Push-Pull Technology for Food Security and Environmental Sustainability in Africa and beyond

RANSFORMING AGRICULTURE IN AREIN AREINE

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## Major constraints to cereal production in Africa



Climate change, Poor soil fertility



Cereal Stemborers Maize lost \$1.5b





Fall Armyworm Maize lost US \$ 6.3b



Aflatoxin contamination

# Push-Pull: a novel concept

•Push-Pull' is a novel concept in pest management, developed by understanding the complex mechanisms that govern the ecology of plants and insects, which uses carefully-selected repellent intercrops and attractive trap plants. Insect pests are repelled from the food crop and are attracted to a trap crop. The repellent intercrop also effectively controls parasitic striga weed.

# First generation Push-Pull







1= (*E*)- $\beta$ -ocimene; 2=  $\alpha$ -terpinolene; 3=  $\beta$ -caryophyllene; 4= humulene; 5= (*E*)-4,8-dimethyl-1,3,7nonatriene; 6=  $\alpha$ -cedrene;

7= hexanal; 8= (E)-2-hexenal; 9= (Z)-3-hexen-1-ol; 10= (Z)-3-hexen-1-yl acetate ;

11= 5,7,2',4'-tetrahydroxy-6-(3methylbut-2-enyl)isoflavanone (uncinanone A); 12= 4",5"-dihydro-5,2',4'trihydroxy-5"-isopropenylfurano-(2",3";7,6)-isoflavanone (uncinanone B); 13= 4",5"-dihydro-2'methoxy-5,4'-dihydroxy-5"isopropenylfurano-(2",3";7,6)isoflavanone (uncinanone C); 14= di-C-glycosylflavone 6-C-α-Larabinopyranosyl-8-C-β-Dglucopyranosylapigenin







# Before and after adopting Push-Pull



#### Second generation Push-Pull: Adapted to Climate Change

The push-pull technology has been adapted to the increasingly dry and hot conditions associated with climate change in Africa to ensure its long term sustainability. The conventional push-pull system had not been extended to drier areas of sub-Saharan Africa, and thus the new research has provided a relevant and effective agricultural innovation for cereal-livestock smallholders living in those areas.





4000

# Push-Pull improves fodder and milk production

Fodder (No. of fresh bundles/ha) 1200 1000 800 before using PPT 600 Now using PPT 400 200 before using PPTNow using PPT Milk (litre/day/cow) before using PPT Now using PPT 2 0 before using PPT Now using PPT Both trap and repellent plants used in >50,000 push-pull the push-pull strategy are of economic farmers have directly importance to farmers as livestock benefited from dairy fodder and help increase milk production. animals

### **Push-Pull Improving Soil Health**



3.0 2.0 1.5 0.5 0.0 PP Mono PP-1998 Mono Treatment

**Total soil carbon** 

Desmodium adds nitrogen to the soil and has a trailing habit, helping conserve soil moisture. It reduces digging and adds to soil organic matter, enhancing the capacity of the soil to sequester carbon. It has a positive effect on plant and insect biodiversity, and has been shown to result in soil that is rich in beneficial micro-organisms.

### Push-Pull improves soil organic matter

#### **Control Field**

#### **Push-Pull Field**

Organic matter plays an important role in giving the soil "crumb structure", so it impacts water infiltration/water holding capacity and is also an important nutrient reservoir that we believe can supply N (and probably P) to crops

# Push-Pull reduces aflatoxin in maize

Significant reduction in foliar and cob damage by stemborer and fall armyworm larvae







# 2016: Invasion of Fall Armyworm in Africa

Fall armyworm has invaded African continent in 2016 ravaging cereal crops across more than 40 African countries causing an annual loss of \$6.25 b. As the most difficult insect pests to control in cereal fields, fall armyworm is causing serious leaf feeding damage as well as direct injury to the tussle and cob.

If solution not found soon, the pest is going to put hundreds of millions of people at the risk of hunger in Africa.

# Push-pull Protects Maize from FAW Damage



Push-pull Maize monocrop

# **Benefits of Push-pull**

- Stemborer control
- Striga control
  - Fodder & milk production
    - Climate change adaptation and mitigation
      - Soil fertility improvement
- Aflatoxin control
- Fall armyworm Control

#### **Push-pull and UN Sustainable Development Goals**





UNITED NATIONS

2015: Push-pull mentioned in UN General Assembly Report



United Nations
General Assembly

Distr.: General 6 August 2015

Original: English

#### Seventieth session

Item 20 of the provisional agenda\*\* Sustainable development

#### Agricultural technology for development

Report of the Secretary-General

Summary

Agriculture in a broad sense, comprising crops, livestock, fisheries and forest products, presents both a migor challenge and a potential solution in terms of sustainable development. Land degradation and soil health, scarcity of and competition for land and water resources, loss and waste of food, the environmental impacts of agrochemicals, biodiversity loss, climate change and natural disasters all affect the ability of producers to ensure food security in a way that is environmentally, coenomically and socially sustainable. The present report examines trends in technologies that have the potential to overcome those challenges and enable producers to transition to more sustainable agricultural systems.

\* Reissued for technical reasons on 9 September 2015. \*\* A/70/150.





A/70/298\*

#### Push-Pull - a knowledge-intensive solution

The Push-Pull technology, developed by the International Centre of Insect Physiology and Ecology, based in Nairobi, efficiently controls pests and improves soil fertility. Push-Pull provides agroecological solutions to some of the most common challenges facing smallholder farmers in sub-Saharan Africa: stem borers, Striga and low soil fertility affecting cereal production. It is based on research by the International Centre and Rothamsted Research on behaviour-affecting chemicals produced by plants and insects.

The technology consists of intercropping maize with a repellent plant, such asdesmodium, and planting an attracting plant, such as napier grass, as a border crop. Stem borer moths are attracted by the volatile compounds of the napier grass and, after the eggs hatch, the larvae get trapped by a sticky substance produced by the grass. Napier grass is also a valuable carbohydrate-rich livestock folder. Desmodium, on the other hand, is a perennial cover crop that repels the moth through its volatile compounds, suppresses Striga, fixes nitrogen, conserves soil moisture, enhances arthropod abundance and diversity, and increases organic matter in the soil.

While providing a pest management solution, Push-Pull makes cereal cropping systems resilient to climate change. The latest version of this technology includes drought-tolerant desmodium, brachiaria as a trap crop and sorghum. Furthermore, it promotes the integration of livestock husbandry, increasing household nutrition via milk products, and diversifies income sources, allowing smallholders entry into the cash economy. As it employs local plant varieties, it integrates well with the traditional mixed cropping system of sub-Saharan Africa.

With respect to its impact, Push-Pull has to date been adopted by nearly 100,000 smallholders in East Africa and has successfully and sustainably doubled and even tripled maize yields.

39. Without private funding, it is difficult to achieve widespread adoption of knowledge-intensive agroecological technologies owing to poor public extension and advisory services. Farmer field schools help to scale up technologies and reach marginalized populations by addressing both technical complexities and the local contexts required for knowledge-intensive practices to be understood and adopted. In a West African regional programme, introducing integrated pest management to 30,000 farmers from a field school resulted in a median pesticide use reduction of 75 per cent, yield increases of 23 per cent and net margins of 41 per cent. In addition, building the capacity of farmers to become trainers can enhance the reach of a successful pilot project.<sup>®</sup>

40. Preharvest losses have a significant impact on food security in rural communities. Therefore, new technologies are needed to reduce food loss and waste. The FAO Global Initiative on Food Loss and Waste Reduction helps develop regional programmes and supports their national implementation, including through

<sup>&</sup>lt;sup>36</sup> FAO, Investing in Food Security (2009). Available from http://www.fao.org/fileadmin/templates/ ag\_portal/docs/i1230e00.pdf.

# Scope of Push-Pull in Africa and Beyond

There are at least 350 million smallholders in sub-Saharan who will benefit from adoption of push-pull technology.

Although push–pull was originally developed for maize production systems, it has been applied equally successfully to sorghum, millet, sugarcane and upland rice.

Research is also being carried out to adapt its application to cotton, coffee and horticultural crops. This adaptability gives it enormous potential for reproduction elsewhere.



**Farmer Field School (FFS)** 

Farmer Teachers (FT)

Murage et al. 2012. Quarterly Journal of International Agriculture 51: 51–71

### DISSEMINATION PATHWAYS AND ADOPTION OF 'PUSH-PULL'



#### **Push-Pull in sub-Saharan Africa**



**KENYA** 

UGANDA



ZAMBIA









RWANDA



TANZANIA

ZIMBABWE



Push-Pull technology, based on ecological principles in its development and dissemination, is a perfect example of how a low-cost, low-input production system can provide a pathway to an 'evergreen revolution ' without causing environmental and social harm.

---- Prof. M. S. Swaminathan, Father of Green Revolution in India

Push-Pull fully supports our vision to boost green economy for Africa as the technology is wholly organic and ecologically sustainable and bypasses all the pitfalls and drawbacks of relying on outside sources and expensive inputs which African smallholders simply cannot afford.

--- Dr. Hans R. Herren, World Food Prize Laureate

l hanks! ANY QUESTIONS? You can find me at zkhan@icipe.org ⊷ <u>www.icipe.org</u> ••• www.push-pull.net Schweizerische Fidgenossenschaft Confédération suisse Contederazione Svizzera Confederaziun svizra



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