Translating basic research on insect-plant interactions to aid in the protection of bean in East Africa

A SCPRID-funded partnership between Cambridge University, Biosciences East and Central Africa in Kenya, International Center for Tropical Agriculture in Uganda and Rothamsted Research-UK

John P. Carr

Department of Plant Sciences

Cambridge University

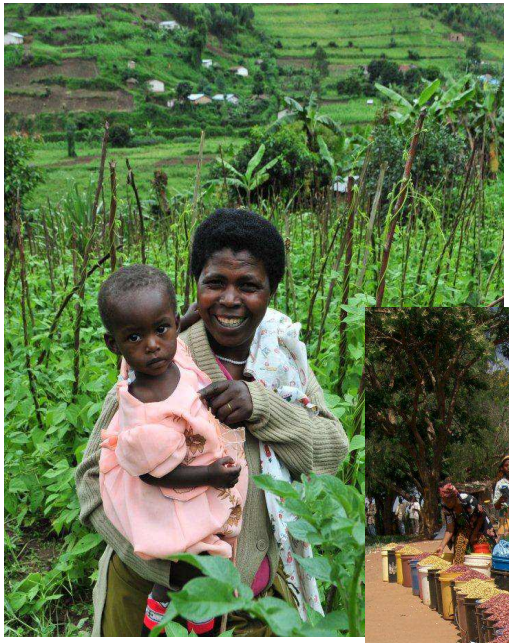
SCPRID Grant: Protecting the bean crop against aphids and the viruses they transmit is important because…

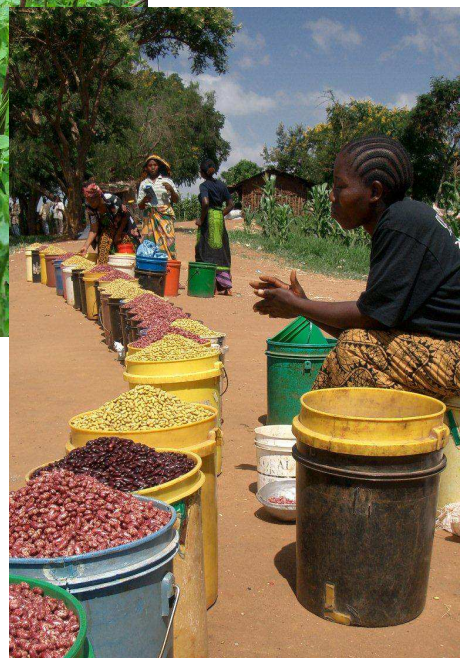
In East Africa smallholder farmers use Common Bean:

-AS THE MAJOR PROTEIN AND MINERAL SOURCES IN THE DIET

- AS AN INTER-CROP TO ENRICH THE SOIL ON FARMS (BEANS ARE LEGUMES THAT HARBOUR *NITROGEN-FIXING BACTERIA* IN THEIR ROOTS)

-AS A CASH CROP (esp. by female growers) TO FUND HEALTHCARE AND EDUCATION





WORK ON BEAN IS DISSEMINATED TO END-USERS VIA THE PAN-AFRICA BEAN RESEARCH ALLIANCE (PABRA) DIRECTED BY OUR CIAT CO-PI, DR ROBIN BURUCHARA

There are three major aphid-transmitted viruses of common bean in East Africa

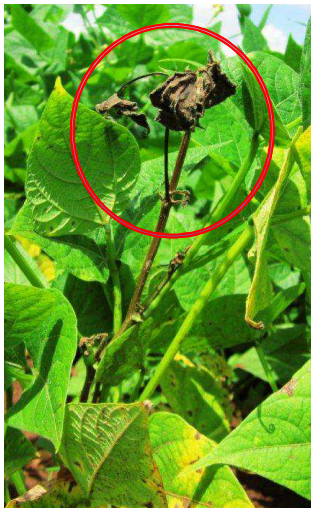
Disease in ‘Wairemu’, a grower-preferred variety that is susceptible to all 3 viruses)

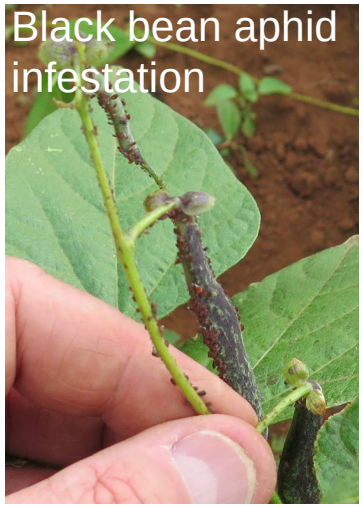
Bean common mosaic virus (BCMV): Worldwide Incidence

Bean common mosaic necrosis virus (BCMNV): ENDEMIC TO EAST and CENTRAL AFRICA

Cucumber mosaic virus (CMV): Worldwide Incidence – Affects other crops too

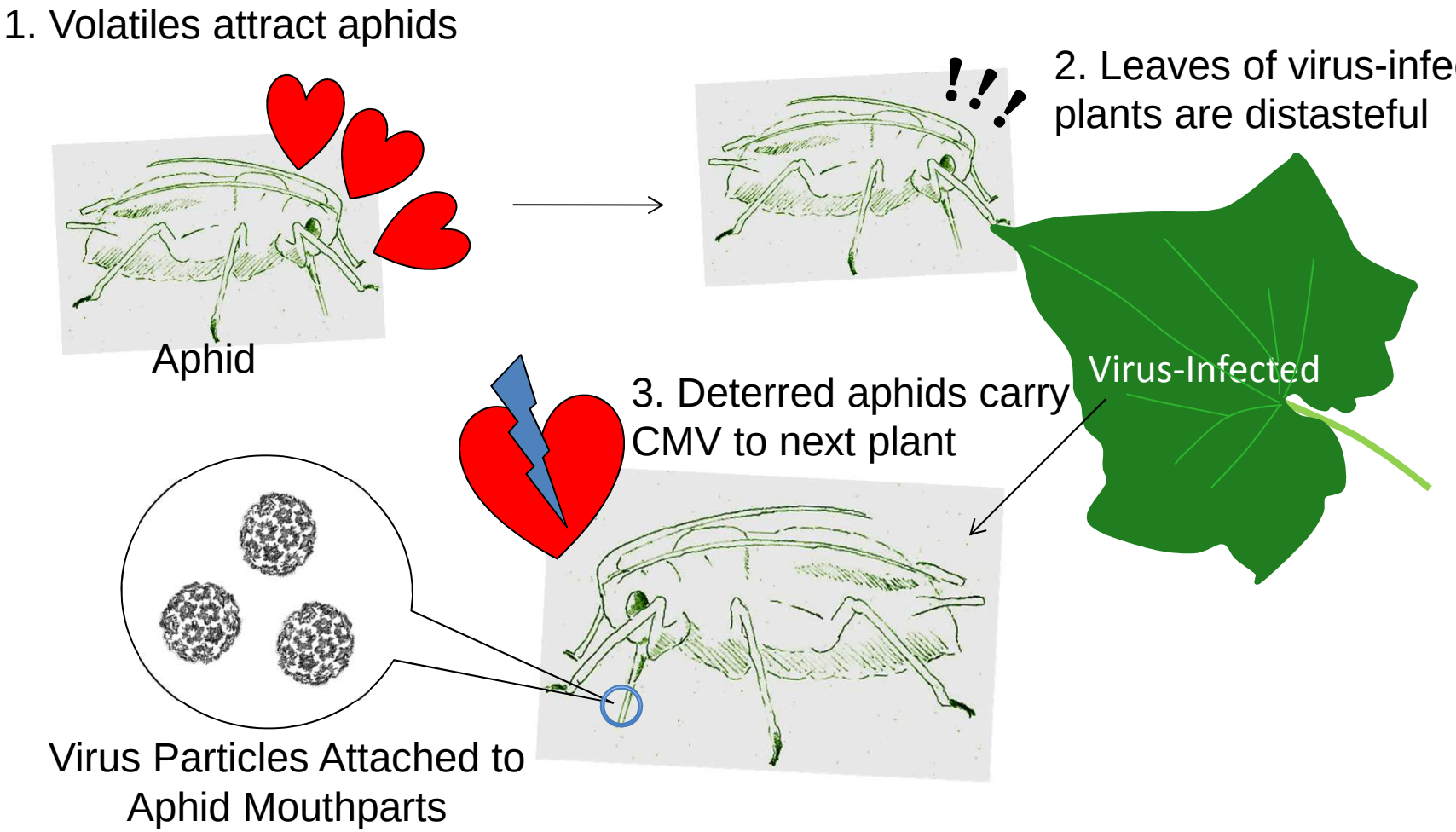
Problem: Bean common mosaic necrosis virus kills bean varieties with the *I*-gene for BCMV resistance





Some plants infected with viruses ‘smell’ better and ‘taste’ worse to aphids

The Virus is Manipulating Host and Vector to Enhance Its Transmission



We need to identify the major aphid vectors and the full range of viruses transmitted

Peach-Potato Aphid

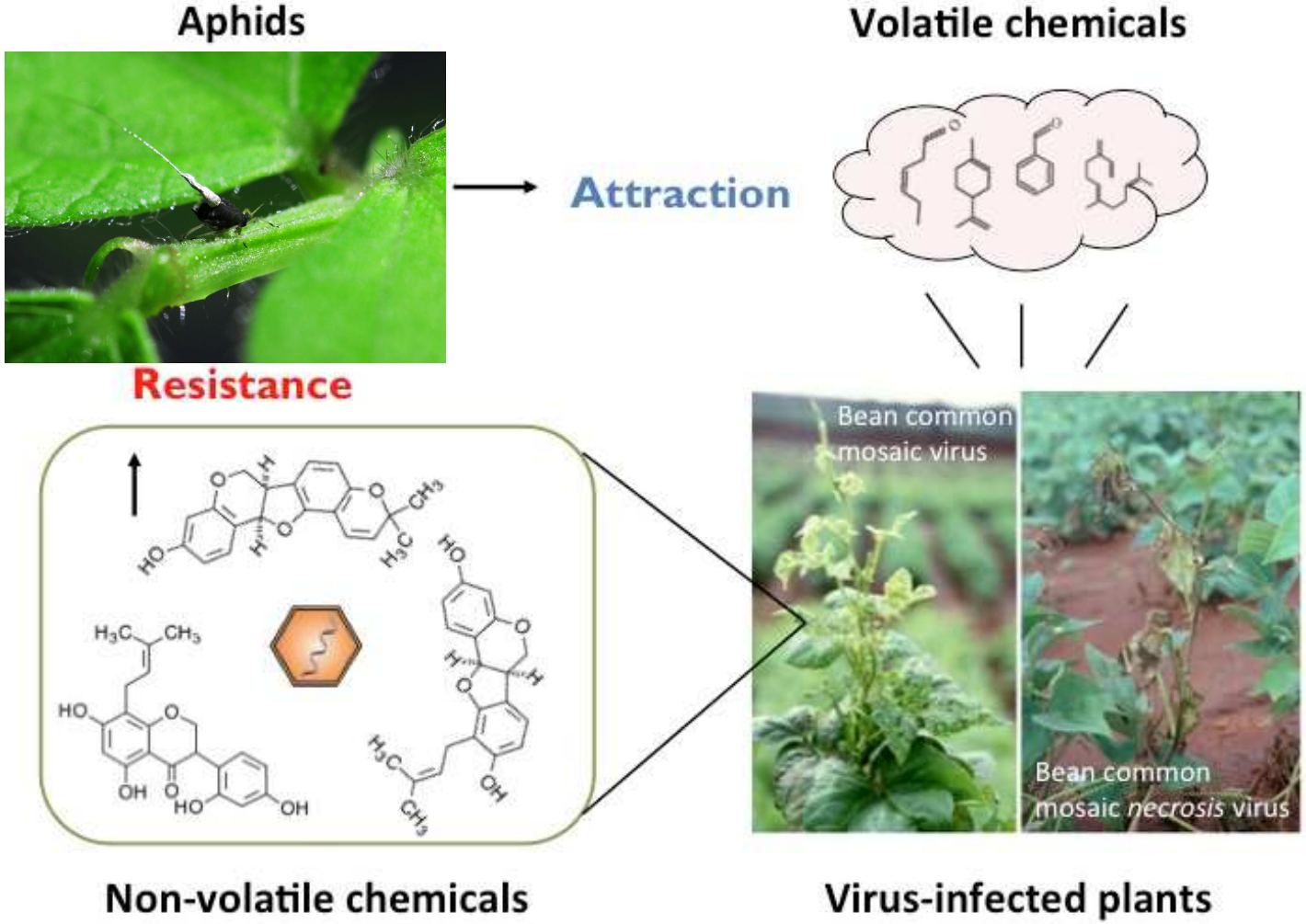
Black Bean Aphid

BecA/Cambridge Team with Farmer Susan Mburu

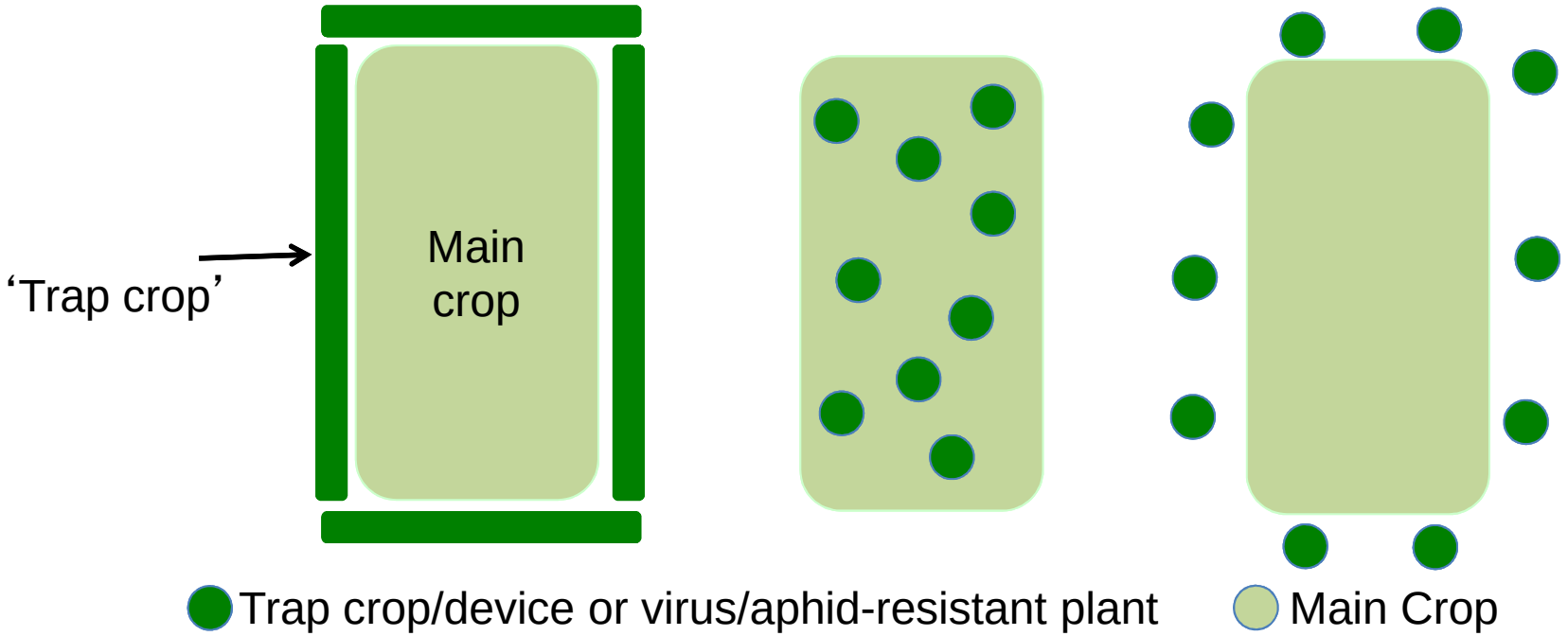
Francis Wamonje collects aphids from leaves while yellow water trap lures winged aphids

Francis isolates insect DNA and viral RNA at BecA-Nairobi

Does virus infection alter emission of ‘semiochemicals’ by beans that affect aphid behaviour?



Can we exploit aphid behavior, resistant lines, semiochemicals and mathematical modelling to design field plots that protect crops from virus disease?



Ongoing work

- Lab experiments to simulate field layouts
- Collaboration with CIAT to translate to field plots
- Mathematical modelling to refine strategy and minimise risk

Acknowledgements

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Sustainable Crop Production Research for International Development (SCPRID)

UKaid from the British people

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BILL & MELINDA GATES foundation

भाकृअनुप ICAR

Modeling and manipulation of plant-aphid interactions: A new avenue for sustainable disease management of an important crop in Africa

Project objective

Develop tools to be used to control the spread of aphid-transmitted virus diseases in beans in Eastern and Central Africa

Epidemiological models, Genes for MAS, small RNAs, semiochemicals, IPM technologies

$$\text{Yield} = \int_0^{harvest} \sum_{i=1,2} \alpha_i w_i(t) S_i(t) \mathrm{d}t$$

$$\frac{\mathrm{d}S_i}{\mathrm{d}t} = \delta_i(S_i) - \beta_i A_v S_i - \varepsilon S_i - d_i(S), \quad \frac{\mathrm{d}I_i}{\mathrm{d}t} = \beta_i A_v S_i - \varepsilon S_i - \mu_i I_i - d_i(I_i), \quad \frac{\mathrm{d}R_i}{\mathrm{d}t} = \mu I_i - d(R_i): \ i = 1,2$$

$$\frac{\mathrm{d}A_0}{\mathrm{d}t} = \pi_0(A_0) + (\sigma_1 + \sigma_2)A_V - (\gamma_1 I_1 + \gamma_2 I_2)A_0 - d_0(A_0), \quad \frac{\mathrm{d}A_V}{\mathrm{d}t} = \pi_v(A_v) + (\gamma_1 I_1 + \gamma_2 I_2)A_0 - (\sigma_1 + \sigma_2)A_V - d_v(A_v)$$