SP2: Development of integrated pest management strategies for the production of important vegetable crops in Kenya

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I. Overall aim and objectives

In Kenya, African indigenous vegetables (AIV) are increasingly popular staples in the diet of local people. They are rich in health promoting compounds (IPGRI, 2003) and assist in combating micronutrient deficiencies and malnutrition (also known as hidden hunger). AIVs also contribute to food security and income generation among the subsistence and semi-commercial farmers in Kenya and Africa. Among AIVs many legumes have been recommended for soil fertility improvement and weed suppression. Multiple uses of legumes have fostered their adoption. Cowpea (*Vigna unguiculata* [L.] Walp.) is the most important food legume grown in the tropical Savanna zones of Africa. The mature grain contains 23-25% protein, 50-67% starch, B vitamins such as folic acid which is important in preventing birth defects, and essential micronutrients including iron, calcium, and zinc. Although a significant amount of cowpea is commercialized, it plays a critical subsistence role in the diet of many households in Africa, providing nutrients that are deficient in cereals.

AIV production is constrained by pests and diseases which severely impacts the quantity and quality available in the value chain. For example, Root-knot Nematodes (RKN) are major pests of vegetable crops (Hassan *et al*., 2010) which cause between 5 - 12% yield losses globally (Sikora/Fernandez, 2005). Nchore/Waceke/Kiriuki (2011) and Muturi et al. (2010) reported RKN disease incidences of up to 60% on African nightshades (AFNS) in parts of Kenya. Similar severe yield reductions, based on a complex of arthropod pests and diseases, have been reported on important local vegetables such as African leafy vegetables and legumes. Pests and diseases lead commonly to an overuse of chemical pesticides in small scale and commercial production systems, causing well-known toxicological and environmental problems. More sustainable integrated pest and disease management is therefore a high priority, furthering the production of healthy vegetables.

Focusing on important vegetable crops in Kenya, the integrated pest management group objectives are to develop sustainable management strategies for a) Root-knot Nematode pests, viruses and phytoplasmas on African nightshades, b) cowpea insect pests and c) insect pests and diseases on leafy indigenous vegetables in Kenya. As vegetable crops face damage through pests and diseases during every stage of their life cycle **the overall aim of the intervention is** to identify infection pathways, in order to develop integrated pest and disease control strategies for increased yield and to ensure crop quality. The **relevance of intervention to the objectives of the project (output)** is given by increasing knowledge, developing adequate management strategies and affordable solutions, which will improve vegetable production and thereby further increase income opportunities and access to nutritive vegetables.

The research and technical goals of the intervention are twofold: to document severity and incidence of diseases and pests on selected vegetables, and generate knowledge on sustainable management of major arthropod pests, nematodes and viral diseases leading to their increased yields and supply.

II. State of knowledge

a. Root-knot Nematode pests, viruses and phytoplasmas on African nightshades

African nightshades are of high impact to food security and income generation among the subsistence and semi-commercial farmers in Kenya. Several pests hamper production of the *Solanum* spp. summarized under the label African Nightshade. They include root-knot nematodes, virus and phytoplasma caused damages. Nchore/Waceke/Kiriuki 2010 and Muturi et al. 2010 reported a RKN disease incidence of up to 60% on African nightshades in parts of Kenya. Several virus infections are also frequently reportedincluding PepMV,

TyLCD, TYLCV, Potato mop top and PLRV (Hughes/Odu, 2003). Bacterial diseases caused by '*Candidatus* Phytoplasma' occur in many *Solanum* spp. and are also reported for African nightshade (Tolu et al., 2006).

Unfortunately, the knowledge of the situation in AFNS on all three pests is limited. Misinterpretation of symptoms often results in wrong plant treatment. To avert further losses, there is an urgent need to develop a sustainable and environmentally sound management strategy while at the same time maintaining high production standards and food safety in conformity with the market requirements. Such an approach will start with the determination of the *Solanum* spp. summarized under the umbrella of African nightshade including *S. nigrum*, *S. americanum*, *S. scabrum*, *S. eldoreti*i and *S. villosum*. Therefore, damages caused by these three groups of pathogens have to be assigned to species and corresponding phenotypes. Screening, determination and on-site diagnostic tools are a central part of this objective. Furthermore, soil treatment with nutrients and the influence of periodical cultivar changes will be evaluated for the management of nematode infections.

All results will be made available through informational material for the local plant protection service and farmers, as well as published in scientific journals.

b. Management of important cowpea pests

The Food and Agriculture Organization (FAO) reported that Kenya produced about 72,274 t of dry cowpeas in 2010 (FAOSTAT, 2010). This economic contribution of the crop can be improved if constraints faced by urban and peri-urban farmers are addressed. These constraints include: arthropod pests and diseases, contamination from toxic chemicals from industries, lack of high yielding cultivars and poor crop management practices. Among the major arthropod pests the legume pod borer (*Maruca vitrata*) (LPB), the cowpea aphid (*Aphis craccivora*), the pod sucking bugs (*Clavigralla* spp.) and foliage beetles (*Ootheca mutabilis*) are the most destructive causing 60-80% damage to foliage, flowers, buds and pods (Jackai/Adalla, 1997). To counter pest problems, farmers use expensive and toxic synthetic chemicals (Jackai/Adalla, 1997) without effectively achieving the desired goals. Therefore, raising cowpea production requires scientific intervention focusing on a better knowledge and understanding of pest bioecology under different urban and peri-urban cowpea farming systems. Among the technologies being developed for the management of the LPB include: a refined sex pheromone system for population monitoring, and the use of biopesticides and botanicals for control of different stages of the pod borer. However, there is still a challenge to adapt these methods to the small scale urban and peri-urban farmer.

c. Production of healthy leafy indigenous vegetables

African leafy vegetables (i.e. Amaranth (*Amaranthus* spp.), African Nightshade (*Solanum scabrum*), Spiderplant (*Cleome* spp.), Ethiopian kale (*B. carinata*) and Rattlepod (*Crotolaria* spp.)) are important sources of human nutrients and household incomes. This has led to promotion of their production and consumption such as in Kenya where production increased by 213% between 2001 and 2006. Many different pest species attack leafy indigenous vegetables, including aphids, often vectoring diseases. Diseases, including bacterial, fungal as well as viral pathogens can cause serious damage of up to 100% yield loss. Effective and sustainable control of many of the pests and diseases fails because of a lack of knowledge on infection pathways (i.e. the origin of the pest is unknown). Especially in field grown vegetables two different ways of infection are possible: (1) infected seedlings grown in plant nurseries and (2) colonization from wild plants (weeds) and/or other crops in the small scale agro ecosystem. For example, the cabbage aphid which colonizes all brassicaceae weeds and crops, vectors about 20 virus diseases. Therefore, multiple infestations on the farm scale

level are more then likely. Due to limited aphid dispersal the immediate neighborhood is most important. To minimize pest problems and use of pesticides, it is mandatory to understand not only the interrelationship between different crops and pest/disease epidemiology but also in time and space. This includes the specific role of crop varieties and cultural practices, in particular fertilization on pest development.
Within the agro-ecosystem of leafy indigenous vegetables in East Africa, pest infection pathways as well as the contribution of cultural practice and crop resistance to pest and disease management has not been explored in detail. Therefore there is an urgent need to consider all factors in a holistic approach to enhance pest management strategies in a sustainable way.

III. Detailed description of work plan

Activity	Milestone	Timeframe	Partner
Objective A: Nematode pests, viruses and phytoplasmas on African nightshades (AFNS)			
PM1: determination of severity/ incidence of root knot nematodes (RKN), plant viruses and phytoplasma on AFNS in the field research sites	M1: Overview on severity and incidence of RKNs, phytoplasma and plant viruses	01.2015–12.2016	HU/B HU/K KU/W
PM2: Optimization, development and validation of diagnostic tools; assess farmers' knowledge and awareness on problems caused by nematodes, phytoplasma and viruses	M2: Diagnostic tools suitable for routine diagnosis of RKN, phytoplasma and viruses	07.2015–12.2017	HU/B HU/K KU/W
PM3: Evaluation of potential management tools (resistant germplasma, organic amendments, prophylactic measures, soil solarization) and development of an integrated strategy; training days for farmers	M3: Recommendation of plant protection tools dependant on specific site conditions	01.2016-12.2017	HU/B HU/K KU/W
Objective B: management tools for cowpea pests			
PM4: To identify, refine and synthesize the chemical components of *M. vitrata* sex pheromone, testing blends in various combinations and environments	M4: Major sex pheromone components of *M. vitrata* identified and field tested	01.01.2013–31.12.2015	HU/U ICIPE/B
PM5: assess the role of botanical insecticides and to test the efficacy of fungal-based biopesticide under varying cropping systems against *M. vitrata*	M5: Effective botanical insecticides against *M. vitrata* identified	01.01.2013–31.12.2015	HU/U ICIPE/E
PM6: Developing IPM strategies for important cowpea pests based on intercropping and plant based insecticides	M6: IPM system for cowpea pests including *M. vitrata* developed and tested in field trials	01.01.2013–31.12.2015	HU/U ICIPE/B
Objective C: pest and disease management strategy for leafy indigenous vegetables			
PM7: Development of IPM strategies for fungal diseases in selected indigenous vegetables	M7: IPM strategies for fungal diseases developed	01.01.2014 – 31.12.2015	JKUAT/T LUH/M LUH/MA
PM8: Monitoring and management of sucking pests and viral diseases in the agro ecosystem of indigenous leafy vegetables	M8: Important sucking pests and diseases identified and efficient control strategies for their control developed	01.01.2014 – 31.12.2015	SE, LM, JW EM, RM, HMP

IV. Utilization of results

Increased knowledge of IPM will help improve early pest and disease diagnostic at **farm** level, while training and dissemination packages will allow **extension and advisory services providers** to offer better support to farmers, through increased knowledge and

tools. At the same time, engaging **policy and decision makers,** such as the Kenya Agricultural Research Institute (KARI) and Kenya Plant Health Inspectorate Service (KEPHIS) both part of the Kenyan Ministry of Agriculture, will help to reap support for further development in the horticulture sector and extent successful methods, projects and strategies to national and regional levels (scale-up). The advancement of existing knowledge and research will allow **research scientists** to develop successful pest and disease-control management methods and tools.

V. Cooperation with other subprojects/cooperation with third parties

Cooperation with other groups will generally involve the sharing of field sites, preparation of guidelines and information material and assistance in trainings for farmers and extension officer.

The IPM group will further cooperate with partners of the following sub-projects:

- “Increasing water use efficiency in indigenous vegetable production systems” Water use alters the quality and susceptibility against pests and pathogens of crops and therefore has to be considered in developed IPM packages.
- “Impact of fresh and processed African leafy vegetables on human health“. Pest and pathogen problems are affecting plants secondary metabolism and therefore the nutritional value of crops.
- “Value chain effects on livelihoods and food security of vegetable producers and consumers”.