Workshop Report

Enhancing farmers' access to improved mungbean varieties and good agricultural practices in Southeast Asia, Kampaeng Saen, Thailand, 23-24 April 2019

This workshop was made possible with the support of long-term strategic donors to the World Vegetable Center: Republic of China (Taiwan), UK aid from the UK government, United States Agency for International Development (USAID), Australian Centre for International Agricultural Research (ACIAR), Germany, Thailand, Philippines, Korea, and Japan.

Contents

1 Workshop objectives and program

This workshop, organized by the World Vegetable Center and Kasetsart University, brought together mungbean crop experts from Southeast Asia and the World Vegetable Center (WorldVeg) for the purpose of exchanging ideas and information about mungbean production in the region. The initiative should lead to the establishment of a collaborative network of mungbean experts to enable the exchange of knowledge and germplasm. More specifically, the objectives of the workshop were to gain a better understanding of: (a) the situation of mungbean production in Southeast Asia; (2) the status of mungbean breeding programs in Southeast Asia; and (3) current constraints and opportunities to mungbean production. The workshop also informed about the current status of the WorldVeg mungbean improvement program and demonstrated a selection of mungbean lines, which should enable mungbean breeders in the region to identify germplasm for use in their improvement programs.

The workshop program gave each country about 30 minutes to provide an update about mungbean research and development with a suggested structure of: (1) Status of mungbean production; (2) description of key uses of mungbean in the country (e.g. export vs. domestic use; market segments including sprouts, dry grain, noodles; consumption and nutritional aspects); (3) key constraints to mungbean production and market development; (4) description of your mungbean breeding program (resources, germplasm, priorities, past successes, constraints); (5) description of mungbean seed production and distribution in the country; (6) how can WorldVeg or an international mungbean network support mungbean R&D in the country. The second day of the workshop focused more on discussions on how to collaborate as part of a network in terms of research priorities, network organization and potential funding sources to support network activities.

2 Presentation summaries

2.1 Delphine Larrousse (WorldVeg)

Delphine welcomed the participants on behalf of the World Vegetable Center. She provided a brief overview about WorldVeg, including its current mission, flagship research programs and regional presence. She also set out workshop objectives.

2.2 Peerasak Srinives (Kasetsart University)

Peerasak welcomed the workshop participants on behalf of Kasetsart University. In his presentation he provided a historical perspective on mungbean research in Thailand, noting that research efforts were particularly strengthened after WorldVeg located its mungbean breeding program at Kasetsart University and the roles of Dr. Charles Yang and H.G. Park. He also told that over 30 students from across Asia were trained on mungbean research in collocation between KU and WorldVeg, including Dr. Xuzhen Cheng and Dr. Xin Chen who now coordinate the mungbean program in China and are here with us today.

2.3 Pepijn Schreinemachers (WorldVeg)

Pepijn gave a global overview of mungbean production, showing which countries are the largest producers of the crop. WorldVeg conducted a study on the adoption of improved mungbean varieties and agricultural practices for 6 countries in Southeast Asia. He presented results for Cambodia, Laos, Thailand and Vietnam. It showed that several of the popularly used varieties in Thailand, Cambodia and Vietnam contain germplasm developed from the WorldVeg international breeding program, but some of it may be rather old. Mungbean production systems vary much between countries and so do the constraints. In

Cambodia, the key identified constraints related to the lack of suitable varieties and low quality seed, in Laos the top constraints related to low prices and unstable markets, while in Vietnam the top-3 constraints were about pest and disease problems.

2.4 Ram Nair (WorldVeg)

Ram presented about the WorldVeg mungbean improvement program. He listed maturity, seed type, and pest and disease resistance as important traits. WorldVeg established an International Mungbean Improvement Network (IMIN) with funding support of the Australian Centre for International Agricultural Research (ACIAR) and this network currently includes research organizations from Australia, Bangladesh, India and Myanmar. The network tested the mungbean minicore collection and provided capacity building, especially in database management (KDDart), planting breeding methods. But the network is not only about breeding, also about good agricultural practices. In Myanmar, Bangladesh and Pakistan the Center is working on mechanical harvesting of mungbean funded by ACIAR, on mungbean seed scaling funded by UK aid, and on seed systems in Myanmar funded by Syngenta Foundation. Ram also introduced the International Mungbean Improvement Network (IMIN) funded by ACIAR and currently including Australia, India, Bangladesh and Myanmar.

Ram talked about the importance of Mungbean Yellow Mosaic Disease in the Indian subcontinent. WorldVeg research in India showed that there are 3 MYMD strains. The screening of the mini-core showed the availability of germplasm material resistant to all three strains. The disease is not seed-transmitted, only transmitted by white flies. Ram also talked about bruchid resistance. The bruchid resistance is now included in dull, brownish and green shiny varieties. Available lines in the WorldVeg catalogue have resistance to the various strains of MYMD and bruchids. He also showed that accessions in the mini-core showed resistance against brown root rot, anthracnose, powdery mildew, and halo blight (*Pseudomonas syringae* pv *phaseolicola*), tan spot (*Curtobacterium flaccumfaciens*), thrips, cowpea aphids. Some of the bacterial diseases are seed-transmitted, which deserves great care in breeding programs.

2.5 Vu Dang Toan (Vietnam)

Mungbean is a traditional crop in Vietnam. It is suitable for many different soil types. The crop has a high economic value compared to many other crops. However, currently most mungbean used in Vietnam is imported from China (especially for sprouting). In Vietnam, mungbean is intercropped with cassava or sugarcane or rotated with other crops such as maize and rice. There is still no variety suitable for machine harvesting. Not enough attention is paid to post-harvest management and processing.

The mungbean research in Vietnam focuses on short maturity varieties (harvested 1-2 times) with yield above 1.6 t/ha (potential yield is calculated based on multiple harvests). Major mungbean varieties have been released: DX208 (mostly used for dry grain), which has a duration of 65-75 days and potential yield of 2 t/ha. Other varieties include T135, V123, KP11, DX044, DXVN7, DXVN10, and DX14. Many of the varieties are selections from introduced varieties from WorldVeg, India and other countries and the national system still does not do much cross-breeding research. There are currently only very few mungbean breeders in Vietnam. Available mungbean germplasm is only about 450 accessions conserved in the national genebank (PRC). The exchange of germplasm with other countries is important for mungbean breeding program in Vietnam.

International support is needed for variety development with high yield and short duration, synchronous maturity and methods for mechanical harvesting. It is also a priority to expand the mungbean area to other parts of the country. The yield of short duration varieties is currently low. It was noted that Vietnam

does have mungbean yellow mosaic virus. Collaborative research with WorldVeg in the "Beating Begomovirus Project" found that MYMV in Vietnam has DNA sequences of DNA-A and DNA-B share 98.7-98.9% and 95.9-96.8% with MYMV collected from Cambodia and Thailand. PRC has screened 400 local accessions against MYMD, but none was resistant. Only 3 WorldVeg materials showed resistance (NM92, NM94, and VC3960-88).

2.6 Prakit Somta (Kasetsart University, Thailand)

Farmers in the uplands grow legumes in the rainy season, in the lowlands it is grown in the dry season from February to April. Sowing is mostly done by broadcasting seed. In Thailand, mungbean is used for sprouts, noodles, and export. Black gram is only for sprouts and exports. Mungbean is mostly grown in central region and central-north and a little bit in the northeast of Thailand. Machine harvesting has become popular and seed broadcasting can be combined with machine harvesting. Handpicking is still used for high-quality seeds for the sprout industry. The economic returns to mungbean production have declined from 2014-2016 as costs have increased. The country also imports mungbean while exporting high-quality grain. Main constraints are low yield (lack of quality seed and broadcasting of seed), low quality seed and grains, high production costs (including high pesticide expenditures).

Research organizations involved in mungbean research include Chai Nat Field Crops Research Center, Kasetsart University, and Suranaree University of Technology. The breeding priority is large seeded varieties, early and synchronized maturity (70 days), resistance to diseases (powdery mildew as occurs during the cool dry season and cercospora leafspot, which is a problem in the rainy season), resistance to bruchids, and resistance to calcareous soils. Currently all Thai cultivars are susceptible to bruchids.

Most of the breeding lines are based on WorldVeg breeding lines because of high yield, large seed and early and synchronous maturity. The KU program is also using breeding lines from India and Philippines. KPS2 still very popular for sprout production. Now KUML3 and KUML4 are gaining popularity; both these varieties have pods above the canopy which make them suitable for mechanical harvesting. Mechanical harvesting creates about 10-20% losses due to damaged grains. Farmers are mostly broadcasting their seed, but are still able to use machine harvesting.

Main constraints to breeding: lack of continuous funding support (low government priority), lack of staff, lack of facilities (e.g. no germplasm room) and suitable research fields, narrow genepool and lack of new elite germplasm (using many old WorldVeg lines). There is therefore a need for new germplasm from WorldVeg. MYMV occasionally occurs in Thailand and it may become an important trait in the future. Another opportunity is the writing of joint funding proposals.

2.7 Sumana Ngampongsai and Arada Masari (Field Crops Research Institute, Thailand)

The Chai Nat research station of the Field Crops Research Institute has the mandate for mungbean and black gram. The mungbean planting area in Thailand is about 135,000 ha in 2016 and 139,000 ha in 2017. About 90% is consumed domestically. Phetchabun Province is the largest producer. Utilization is mostly for sprouts, vermicelli, and deserts. However, Sumana estimates that sprout production currently uses about 90% black gram as they keep better and the price is sometimes cheaper.

Main production constraints are drought and nutritional deficiency, water logging. In terms of diseases, the major problems are powdery mildew, MYMV disease. Insects: bean fly, maruca, thrips, and bruchids.

Dr Arada Masari presented about the genetic resources of mungbean and black gram in Thailand. The DOA has a collection of about 5000 accessions of mungbean and black gram (about 4000 of these come from WorldVeg) and also has a smaller collection in long-term storage in the DOA seed bank. DOA has released 5 mungbean varieties since 1985: the most recent ones are: Chai Nat 60, Chai Nat 36 (1991), Chai Nat 72 (1999), Chai Nat 84-1 (2012), Chai Nat 10 (2019). Black gram varieties include: Chai Nat 80 (2007), Chai Nat 2 (2005), Chai Nat 4 (2018), Chai Nat 6 (2018). Arada also described the current breeding efforts, which focus on powdery mildew and anthracnose disease resistance, common cutworm resistance, large seed size, and early maturity. Most of this is done using conventional breeding methods. Mutation breeding is done in collaboration with IAEA. There is also an ongoing seed distribution project with KOPIA (2016-2018) using farmer groups to produce certified seed.

2.8 Rodel G. Maghirang (Philippines)

The production area in the Philippines is about 45,000 ha and this is about static over the last 10 years. National consumption about 4 kg/capita/year. The country is producing only about half of its consumption. Mungbean is used as grains, sprouts and cake (for which yellow mungbean bean is used). The country has a strategic plan for mungbean. Sowing by drilling gives much better performance, but most farmers simply broadcast the seed. Harvesting is mostly done by hand.

There is a long history of mungbean breeding in the country. Main research organizations include the Bureau of plan industry and the Institute of Plant Breeding, UPLB. There are about 35 released varieties in the country, but there is still a preference for certain older varieties. Variety development focuses on drought and partial shade tolerance. Shade tolerance is important because of intercropping with cassava and coconut palm. There is also research on flood tolerance. UPLB has developed Pagasa 5, Pagasa 7, Pagasa 9, and Pagasa 21. R&D needs include germplasm, mechanical planters and harvesters, for small-scale production.

In terms of private companies, East West Seed and Ramgo sell mungbean varieties. Interestingly, some traders sell seed called “Australia” or “Burma”, which is just mungbean grain imported from these countries and then some traders sell it as seed. However, these are mixtures of varieties and may not perform well because of differences in latitude.

2.9 Siviengkhek Pommalath (Laos)

The mungbean area in Laos is only about 2,160 ha. The official data show a high yield of 1.7 t/ha, but this conflicts with farmers’ experience. Mungbean production is mostly used for local consumption for sprouts and cake. Many packaged mungbean products are imported from Thailand and Vietnam.

NAFRI started a legume program in 2009 and mungbean research started around 2011. Last year, 42 samples were imported from WorldVeg, but better advice is needed on which lines are suitable for local conditions. The capacity in mungbean breeding is very limited. The breeding objectives are increasing the genetic diversity, high yield. There is an ongoing cooperation with IAEA since 2014 on mutation breeding. NAFRI produces about 500 – 1000 kg of seed per year for distribution to farmers. Some of the popular varieties come from Vietnam and Thailand.

Main constraints include market access, competition with main crops, lack of local processing, lack of improved varieties, low productivity. Market access is an important constraint for farmers. Farmers complain that they cannot sell mungbean. However, in the city there is imported mungbean products for sale. Hence, market linkages need to be strengthened. Almost all mungbean produced in Laos is organic

as farmers do not use fertilizers or pesticides. Government wants to expand legume production, especially in the dry season to improve soil fertility in rotation with maize and rice.

In terms of research, there is a lack of human capacity: no one is a specialist on mungbean, lack of breeding material, and lack of research funds. Support from WorldVeg could include germplasm (breeding material), human resource development (on-job long-term training), and research proposals development.

2.10 Dian Adi Anggraeni Elisabeth and Ratri Tri Hapsari (Indonesia)

Soybean, groundnut and mungbean are the main legumes consumed in Indonesia. The crop is an important source of protein and is relatively affordable to the population. It is suitable for the Government of Indonesia's (GoI) program to overcome malnutrition (stunting) in some areas of Indonesia. It is also an important cash crop due to its short duration and relatively stable price. Mungbean production has reduced from about 300,000 in 2008 to about 250,000 in 2017. The main production areas are in Central Java, East Java, West Java, West Nusa Tenggara, East Nusa Tenggara and South Sulawesi. Each production region of Indonesia has its own preferences for mungbean varieties (e.g. large vs. small seeded, seed color, maturity) and also the uses vary by region. Each mungbean variety has its own physical and chemical properties affecting its suitability for food processing. The main production constraints are land competition with more profitable crops, low quality seed, lack of information and lack of access to improved varieties as well as low-intensive cultivation methods. There is an active collaboration with the private sector in seed marketing. For instance, East-West Seed Indonesia/Ewindo has a target to produce 60 tons of VIMA 1 seed in 2019, which is an improved variety released by the Indonesian Legumes and Tuber Crops Research Institute (ILETRI) in 2008 and licensed to Ewindo since 2018. The production target for 2023 is 1,800 tons, which would cover 30% of national seed demand.

Average direct consumption of mungbean has decreased from 0.37 kg/capita/year to 0.14 kg/capita/year in 2017 because the consumption trend has switched to processed foods and beverages. The food industry is the main user of mungbean (56% of production). For instance, mungbean is used in instant drinks, milk, as snack filler, weaning food, vermicelli and many other products. Dian presented a range of innovative food products made from mungbean such as ice cream, yoghurt and *tempe* (a fermented soybean originating from Indonesia), protein isolate for meat analog, and composite flour) as well as non-food uses such as in cosmetics.

Ratri explained that Indonesia has released 24 mungbean varieties from 1945-2019. ILETRI is one of the Technical Implementation Units (UPT) of the Indonesian Agency for Agricultural Research and Development (IAARD). ILETRI has the task to conduct research on legumes and tuber crops, the main crops being soybean, groundnut, mungbean, cassava, and sweet potato. The institute has five experimental fields in east Java. Farmers prefer varieties with high yield, early maturity and with small to large seed size (in Indonesia they define 3 seed sizes: small, medium and large), the preference is for glossy or dull seed colors.

The mungbean breeding program aims for high productivity, early maturity, small-large seed size, synchronous harvesting, resistance to major pests and disease and a range of other breeding targets. The germplasm collection includes 1,074 accessions (30% of which were obtained from WorldVeg). Since 1994, 10 varieties were released, all of which came from ILETRI. Ratri presented information about VIMA 1, VIMA 2 and VIMA 5 based on WorldVeg germplasm and about VIMA 3 and VIMA 4 based on ILETRI germplasm. Mostly conventional breeding methods are used. VIMA 1 currently dominates seed

production by ILETRI (followed by VIMA 3 and VIMA 2) in 2018. VIMA 4 and VIMA 5 are going to be produced in 2019 by ILETRI for breeder seed and foundation seed. Opportunities to collaborate with WorldVeg could include the exchange information on desired characteristics, exchange of genetic material, joint projects, and capacity building.

2.11 Kean Sophea (Department of Horticulture, Cambodia)

In Cambodia, mungbean is produced nationwide, especially in lowland areas as a second crop after rice. Mungbean is not a priority crop in Cambodia, with more attention paid to soybean and cassava. The area under mungbean in 2015 was 60,652 ha and the average yield is about 770 kg/ha. About 55-65% of mungbean output is exported.

The key production constraints are lack of quality seed, imported seed (e.g. from Vietnam), diseases (cercospora leaf spot, powdery mildew, MYMV), input limitations lack of extension services, poor knowledge, high labor costs lack of irrigation, unstable markets, and lack of public and private sector investment. The mungbean breeding program has produced 6 varieties (e.g. KK2, KK3, CARDI Chey, CMB01), but all of these are very old varieties. Opportunities for collaboration with WorldVeg include capacity building of researchers, quality seed production, development of mungbean germplasm, exchange information.

2.12 Xuzhen Cheng (Chinese Academy of Agricultural Sciences - CAAS) and Xin Chen (Jiangsu Academy of Agricultural Sciences - JAAS), China

In China, the total area planted is about 800,000 ha and the yield is about 1,350 kg/ha. The price of mungbean varies by season and normally peaks from August to October. In general, the price has seen an upward trend from 2004 to 2015. About 45% is directly consumed and about 30% is processed (e.g. for cakes). The country has 11 large mungbean production factories producing 0.3 million tons of sprouts a year (in addition to thousands of small factories). The country does not use black gram for sprouting, only mungbean bean, although many other sprouts are also produced (e.g. barley, wheat, sunflower). There is a strong increase in consumption. Key production constraints include low yields compared to other crops, lack of arable land, plant diseases insect pests and weeds, high cost of labor, lack of processing facilities.

Breeding objectives include high yield (3 t/ha), early and synchronous maturity, resistance, bruchids resistance, salt and drought tolerance. There are about 30 research groups working on mungbean in China, including about 120 scientists. The main groups are at CAAS JAAS, HAAS, and SAAS. The country has its own core mungbean collection. The use of marker assisted selection started about 4 years ago. They did also bruchids resistance gene mapping. Hybridization with azuki bean and rice bean is used in bruchids-resistance breeding. Many of the new varieties are based on WorldVeg germplasm (especially VC1973A).

2.13 Roland Schafleitner (WorldVeg)

Roland presented about the mungbean genebank collections. The total mungbean collection is large and therefore difficult to use for breeders. One approach is to develop a core and mini-core collection. The first core collection was made in China. Roland described how the WorldVeg core collection was created from a larger collection of 5,234 accessions. The collection was stratified based on geographical origin and data were available on many morphological characteristics. Cluster analysis was used to create a phylogenetic tree. Then 20% of the accessions/cluster were randomly selected to form a core collection. The core collection has 1,481 accessions, which is still large and this was therefore further reduced to a mini-core collection of 296 accessions. This was done using the alleles. Genotyping by sequencing was

then applied and narrowed down to a set of polymorphic markers. The mini core collection has already been distributed to many countries in Africa, Asia and also to Canada. The evaluation of the mini core follows a standardized method and uses KDDart as a centralized data management tool. The evaluations have already shown several novel traits.

WorldVeg is now setting up a phenotyping facility in Taiwan (Phenospex technology), which will be used for vegetables as well as mungbean. Collaborators will also be able to use the facility. The next step is to connect genotypes with phenotypes, but the success so far has been limited. Sometimes the disease incidence is low, which does not create enough variation in the data. Priority is now to improve the trait mapping capacity, including phenotyping and genotyping of the core collection and making a larger mini core collection for discovery of complex traits.

3 Demonstration trial of mungbean lines

Twelve mungbean lines from WorldVeg (6 lines), Kasetsart University (4 lines) and Chai Nat Research Station (2 lines) were demonstrated in a randomized controlled block design with 3 replications. The plot size was 1.2 m x 0.8 m and spacing was 40 x 20 cm. The sowing date was 22 February 2019 and plants were ready for first harvesting. KPS2 was used as a check around the plot. The 6 WorldVeg lines are catalogued lines and seed of these can be ordered through the WorldVeg online seed catalogue.

4 Research priorities

Each country team constructed a list of the top-5 priorities for their mungbean breeding programs as shown in Table 1 below.

Table 1. Priorities for mungbean improvement research in Southeast Asia and China

Rank	Laos	Cambodia	Vietnam	Indonesia	Thailand	Philippines	China
1	High yield (2 t/ha)	High yield (2 t/ha)	High yield (2.5 t/ha)	High yield (2 t/ha)	Yield stability (1.8 t/ha)	High yield (2 t/ha)	High yield (2.5 t/ha)
2	Synchronous maturity (80% of pods)	Synchronous maturity (80% of pods)	Synchronous maturity (80% of pods)	Early (60 days) and synchronous maturity (80% of pods)	Powdery mildew resistance	Synchronous maturity (80% of pods)	Cercospora leafspot resistance
3	Early maturity (60 days)	Tolerance to acid soil (pH4-5)	Softer seed (for easy cooking)	Pod borer resistance	Bruchids resistance	Extra early maturity (45-50 days)	Bruchids resistance
4	Drought tolerance	MYMD resistance	MYMD resistance	Cercospora leafspot resistance	Cercospora leafspot resistance	Water logging tolerance	Early maturity (60 days)
5	Bruchids resistance	Bruchids resistance	Bruchids resistance	Salt tolerance (EC 7)	High starch content	Bruchids resistance	Powdery mildew resistance

5 New partnership for mungbean improvement research

This session of the workshop focused on the creation of a new long-term strategic partnership in the area of mungbean research. The participants agreed that coming together as a group brings significant benefits such as learning new things from each other about germplasm and varieties, gaining practical knowledge about plant breeding, information sharing about new mungbean uses, common pests and diseases and its management, anticipating future challenges in mungbean production, the identification of knowledge gaps, and international networking. There are only very few mungbean experts in each country and international collaboration is therefore particularly important in this area.

Participants reached agreement to establish an International Mungbean Improvement Network (IMIN) based on the existing network currently in place, which includes Australia, Bangladesh, Myanmar and India based on a project funded by ACIAR. The initiative would expand the IMIN to include all countries present at the meeting.

The scope of the network was discussed. The core members of the network would be mungbean crop experts, who are mostly mungbean breeders, but the network would not just be about breeding but also work on other areas of common interest such as mungbean promotion, seed production, mechanization, postharvest technologies, and the use of mungbean in the food industry. The connection with the private sector is also important for the network and private companies would hopefully also join the network as members. Hence any organization, public or private, with an interest in mungbean research and development could join the network. There would be no "country representatives" as all members would simply represent their organization.

The success of the network will depend on the commitment of the members to share resources. The idea would be that each member signs a memorandum of commitment with WorldVeg in which each member pledges to:

1. Ensure continuity by appointing a point of contact and an alternate point of contact
2. Try and participate in annual network meetings
3. Share any information on mungbean with the network, through email or the twice annual newsletter "Mung Central"
4. Share germplasm between network members
5. Inform the network of any new varieties released
6. Contribute to joint project proposal development
7. Be responsive to information requests

There will be no annual fee for network membership. WorldVeg will not be able to financially support members to come to the annual workshop. Members would have to allocate own funds for their participation by including this as an expense item in their current or future mungbean projects. A trip to Bangkok (which may be the easiest to reach and cheapest location to hold the meeting) including food and accommodation for 4-days costs about US$ 500 per person for most countries in Southeast Asia.

6 Project development

The network does not currently have funding and hence we need to emphasize fund raising to support the network as well as to develop special projects in areas of common interest. We don't expect that a

single donor would support the whole network and it would also be better for the sustainability of the network if it was funded by multiple donors.

The network has huge potential for donor interest because the potential for large-scale impact in the region. Mungbean has nutritious, environmental, and economic benefits and there is also a high demand for mungbean. Currently there is a lot of interest in pulses (e.g. the EAT Lancet Commission report, the international year of pulses in 2016, IDRC 10-year pulses strategy, international pulse day on 11 February).

Each donor has particular themes they focus on. We need to identify donors that have topics that we care about. For instance, health and nutrition (BMGF), agriculture (ACIAR, KOICA), food security (DFID, IDRC), climate change (SIDA, SDC). One of the SDGs is specifically about partnerships and hence we need to try and leverage our mungbean network with donors.

7 Next steps

A memorandum will be drafted in the coming months and share with all partners for review before a final version is send around for signing. In the meantime, each organization needs to identify a point of contact and an alternate point of contact, and person authorized to sign the memorandum (e.g. university rector or institute director).

Each member will actively work to attract funding for the network and for projects that build on the network. We will plan a next meeting of the international mungbean improvement network around April-May 2020 (likely to be held in Bangkok again) and this will be announced as soon as possible. The WorldVeg contact person for any questions related to the network is Ram Nair.

Annex 1: Workshop program

Tuesday 23 April 2019

Time	Title	Presenter
09:00-09:15	Welcome, introductions and workshop objectives	**Delphine Larrousse**, Regional Direction – East and Southeast Asia, World Vegetable Center
09:15-09:30	Welcome address Kasetsart University	**Peerasak Srinives,** Kasetsart University, Thailand
09:30-10:15	Results from a survey of mungbean production in Southeast Asia	**Pepijn Schreinemachers**, Flagship Program Leader – Enabling Impact
10:15-10:45	Break	
10:45-11:30	Status of the mungbean improvement program at World Vegetable Center	**Ramakrishnan M. Nair**, Global Plant Breeder – Legumes, World Vegetable Center
11:30-12:00	Status of mungbean in Vietnam	**Vu Dang Toan**, Plant Resources Center and **Le Kim Hue**, Legumes Research and Development Center
12:00-13:00	Lunch break	
13:00-13:30	Status of mungbean in Thailand – KU program	**Prakit Somta**, Department of Agronomy, Kasetsart University, Thailand
13:30-14:00	Status of mungbean in Thailand – Field Crops Research Institute program	**Sumana Ngampongsai** and **Arada Masari**, Chai Nat Field Crops Research Center, Thailand
14:00-14:30	Status of mungbean in the Philippines	**Rodel G. Maghirang**, UPLB-Institute of Plant Breeding, Laguna, Philippines and **Andres Godwin C. Sajise**, Philippine Genome Center-Agriculture
14:30-15:00	Status of mungbean in Lao PDR	**Siviengkhek Pommalath**, Maize and cash crop research center, Lao PDR
15:00-15:15	Break	
15:15-15:45	Status of mungbean in Indonesia	**RT Hapsari** and **Dian Adi Anggraeni Elisabeth**, Indonesian Legume and Tuber Crops Research Institute, Indonesia
16:00-17:00	Field tour to inspect selected mungbean lines	**Somchit Pruangwitayakun**, World Vegetable Center
18:00-19:30	Dinner	

Wednesday 24 April 2019

Time	Title	Presenter
09:00-09:30	Status of mungbean in Cambodia	**Kean Sophea**, Department of Horticulture, Cambodia
09:30-10:00	Status of mungbean in China	**Xuzhen Cheng**, Chinese Academy of Agricultural Sciences (CAAS) and **Xin Chen**, Jiangsu Academy of Agricultural Sciences (JAAS), China
10:00-10:30	Break	
10:30-11:15	World Vegetable Center mungbean core and mini-core collections	**Roland Schafleitner**, Flagship Program Leader – Vegetable Diversity and Improvement
11:15-12:00	Discussion about mungbean breeding priorities for Southeast Asia	**Ramakrishnan M. Nair**
12:00-13:00	Lunch	
13:00-14:00	Discussion about a new partnership on mungbean improvement research	**Pepijn Schreinemachers**
14:00-15:00	Discussion about grant proposals to be written	**Delphine Larrousse**
15:00	Break	
16:00-20:00	Short sightseeing and dinner	

Annex 2: List of participants and contact details

A. Country participants

Person name	Country	Organization	Department	Email
Prakit Somta	Thailand	Kasetsart University	Department of Agronomy, Faculty of Agriculture at Kamphaeng Saen	
Peerasak Srinives	Thailand	Kasetsart University	Professor Emeritus and Vice President of KU Council	
Kularb Laosathit	Thailand	Kasetsart University	Postdoctoral researcher	
Sumana Ngampongsai	Thailand	Field and Renewable Energy Crops Research Institute	Main office, Bangkok	
Achara Jomsangawong	Thailand	Field and Renewable Energy Crops Research Institute	Chai Nat Field Crops Research Center	
Arada Masari	Thailand	Field and Renewable Energy Crops Research Institute	Chai Nat Field Crops Research Center	
Rodel G. Maghirang	Philippines	University of the Philippines Los Baños	UPLB-Institute of Plant Breeding	
Andres Godwin C. Sajise	Philippines	University of the Philippines Los Banos	Philippine Genome Center-Agriculture	
Genevieve Mae Aquino (was unable to attend)	Philippines	University of the Philippines Los Banos	Office of the Vice-Chancellor for Research and Extension	
Ratri Tri Hapsari	Indonesia	Indonesian Legume and Tuber Crops Research Institute (ILETRI)		
Dian Adi Anggraeni Elisabeth	Indonesia	Indonesian Legume and Tuber Crops Research Institute (ILETRI)		
Rohim Firdaus	Indonesia	Ewindo (East-West Seed Indonesia)		
Kean Sophea	Cambodia	General Directorate of Agriculture	Department of Horticulture	
Siviengkhek Pommalath	Lao PDR	National Agriculture and Forestry Research Institute (NAFRI)	Maize and cash crop research center	
Vu Dang Toan	Vietnam	Vietnam Academy of Agricultural Sciences (VAAS)	Plant Resources Center	

Person name	Country	Organization	Department	Email
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