ANNEX 3

# Part B. Summary of Country Reports on Production of Super water absorbent (SWA) by Radiation Processing

**(1) Bangladesh (Md. Emdadul HAQUE, Bangladesh Atomic Energy Commission)**

Super Water Absorbent (SWA) was synthesized using three combinations i.e, (a) acrylamide /CMC, (b) acrylamide-Acrylic Acid and (c) Acrylic Acid–CMC. It was found that 3% CMC with acrylamide gives a good gel fraction and swelling value. The maximum swelling values of Acrylamide/CMC SWA is obtained at 48 hours standing in water. 25 kGy radiation doses can be considered as required radiation dose for the preparation of SWA from Acrylamide/CMC. Swelling of Acrylamide/CMC SWA significantly depends on swelling medium. The swelling properties of SWA in water are higher than those of SWA in salt solutions. Swelling ratio of Acrylamide–CMC SWA increases with increased pH values of buffer solution

The maximum gel fraction of Acrylamide-Acrylic Acid hydrogel is obtained at 25 kGy radiation dose. Swelling ratio of Acrylamide-Acrylic Acid hydrogel increases with increased acrylamide content in hydrogel. The maximum water absorption of Acrylamide-Acrylic Acid hydrogel is obtained at 30 hours standing time in water.

The swelling ratio of Acrylic Acid-CMC Hydrogel increases with increased CMC content in hydrogel.

**(2) China (Dr. WU Guozhong, Shanghai Institute of Applied Physics)**

Some works have been done previously in China for radiation grafting of acrylic acid and/or acrylamide onto natural polymer such as starch and cellulose, in order to prepare superwater absorbent. However, because superwater absorbent has been already commercialized, there is almost no work on such topic in recent years.

**(3) Indonesia (Dr. Darmawan DARWIS, National Nuclear Energy Agency of Indonesia)**

Super Water Absorbent Hydrogel was made by gamma radiation crosslinking of cassava, acrylic acid and potassium hydroxide at 10 kGy. Hydrogel Produced have high water absorption capacity up to 300 times of its dry weight and 80 % of gel content. Immobilization of oligoalginate aqueous solution 5% onto SWA was done. The ability of SWA to absorp oligoalginate solution and the release of oligoalginate from SWA were evaluated. The results showed that maximum absorption of oligoalginate by SWA is about 50%. Released of oligoalginate entrapped in SWA is pH dependent. Maximum release of oligoalginate was found at pH 7. About 37 % of oligialginate was release after immersion in water for 2 months while at pH 5 and pH 8, the oligoalginate release was 20% and 27%, respectively. Immobilization and release of *Azotobacter* sp and *Bacillus circulans* bacteria as biofertilizer were also evaluated. The concentration of *Azotobacter* sp and *Bacillus circulans* bacteria used was $10^{12}$ cfu, respectively. Compost and SWA with composition of 100% compost, 3:1, and 1:1 were used as a carrier for bacteria. The results showed that, in all of carrier containing SWA, concentration of viable *Bacillus circulans* bacteria decrease during one week of incubation time and it was increase with increasing incubation time up to 11 days. While for *Azotobacter* sp bacteria, the concentration is decrease continuously with incubation time up to 11 days. The decrease of both bacteria is probably due to unreacted acrylic monomer which may be toxic to bacteria. Pot test of SWA on Zea Mays plant in regosol (entisol) soil was also done. SWA concentrations of 0.025; 0.1; and 0.2 g/g soil were used. During one month evaluation, the results showed that application of SWA resulted in increase of plant high , number of leaf and width of leaf. Optimum concentration of SWA is 0.2g/gram soil

**(4) Japan (Dr. Andry RAVOLONANTENAINA Henintsoa, Tottori University)**

This study evaluated the one year longevity effect of CMCs processed by radiation on physicochemical soil properties and tomato development on sandy soil under saline irrigation based on the 2011 and 2012 data. A decrease in total carbon and nitrogen was found in the soil after 2012 experiment as compared to that in 2011. Soil saturated hydraulic conductivity ($K_S$) decreased with increasing the CMCs mixing rate. The effect of CMCs grain size on $K_S$ is significantly apparent particularly under saline irrigation. After 2011 experiment, CMCs were significantly efficient in increasing the plant water availability soil moisture; however, its significance decreased as the polymer concentration decreased after 2012. The one year longevity effect of the CMCs on water absorption as result of the fresh water and saline water was relatively the same.

**(5) Kazakhstan (Mr.BEKMURATOV Timur, Institute of Nuclear Physics)**

In Kazakhstan, the following technologies have been developed:

- Production of hydrogel wound dressings;
- Production of track membranes for filtering;

For production of SWA, there is a need to determinate optimum raw material, and method of irradiation by using EB-machine.

**(6) Malaysia (Dr. Kamaruddin BIN HASHIM, Malaysian Nuclear Agency)**

Sago waste and empty fruit bunch oil palm are indigenous natural resources produce in Malaysia. Utilization of it will increase it value added and reduce waste to the environment. SWA sago waste based on CMC 250kD with DS 0.9 produce the highest swelling up to 245g/g dry gel. SWA sago waste has higher swelling (245g/g) than the SWA produce from EBF (230g/g) with same parameter condition. SWA EFB mixed with CMC 250kD is higher than CMC 700kD, 230 g/g and 177g/g, respectively. SWA retain the water level in the soil even though the porosity of the media increased. Plant without SWA will be dying after 1 month without water. While the plant with 1% SWA can survive up to 2 months without adding water. However, the plants with 2% and 3% SWA do not growth well based on the leaves. It can only survive.

**(7) Philippines (Ms. Charito ARANILLA, Philippine Nuclear Research Institute)**

Production of CMkC SWA is still in laboratory scale. Two (2) pot experiments on the application of CMkC SWA hydrogel are on-going. A randomized block design was used to assess the effect of CMkC SWA hydrogel in sandy soil and yield/yield components of soybean and corn. Various concentrations of CMkC SWA hydrogel (0, 0.1, 0.3, 0.5%) was mixed with sandy soil with 5 replicates for each treatment. Appropriate amount of fertilizer was applied. Harvest time was not due yet so only the effect on yield components (height and number of pods) for soybean was reported. In terms of height, no significant difference among the treatments was observed. In terms of number of pods, significant difference was observed. Treatments with CMkC SWA gave higher number of pods per plot.

**(8) Thailand (Dr. Phiriyatorn SUWANMALA, Thailand Institute of Nuclear Technology)**

Superabsorbent was synthesized by radiation-induced graft polymerization of acrylic acid onto cassava starch. The synthetic parameters such as absorbed dose and the amount of monomer were investigated in order to determine the optimum conditions for the grafting polymerization. The criteria are emphasized by the optimum conditions of important parameters to give a maximum amount of water absorption. In addition, water retention, germination percentage and germination energy were determined in order to evaluate the possibility of superabsorbent in agricultural applications, especially in arid regions. The graft copolymer was characterized by FTIR. The results indicated that the sand mixed with 0.1%wt superabsorbent can absorb more water than the sand without superabsorbent. The germination energy of corn seeds mixed with 0.5% superabsorbent was obviously higher than those without superabsorbent. This is attributed to the fact that superabsorbent can not only absorb large amount of water but also have good water retention capacity. The experimental results showed that the superabsorbent have considerable effect on seed germination and the growth of young plant. The pot tests of *Tagetes erecta L.* with use of the superabsorbent were positive. The field test were done with rubber tree and bamboo. Superabsorbent can increase the survival rate of rubber tree and induce the bamboo shoot during summer. The future plan for this project is to establish cooperation with TINT's Business Development Unit in order to carry out a case study for a business potential to commercialize the super water absorbent for agricultural purposes.

**(9) Vietnam (Dr. Le Quang Luan, Vietnam Atomic Energy Institute)**

The report namely "agricultural application of super water absorbent prepared by radiation crosslinking and grafting" mentioned the research and application activities in Vietnam. The results on the application of SWA for minimizing the environmental pollution in livestock excrement composting indicated that the SWA prepared by radiation grafting AAc onto starch at 4 kGy were suitable for fermented composting of livestock excrement. The addition of 1% hydrogel increased the hydrolysis effectively of cellulose in excrement in 5% after 45 days fermentation. The bio-organic fertilizer fermented with hydrogel showed a good growth on *Brassica* vegetable. The SWA showed a potential application for composting the livestock excrements to produce of multifunction bio-fertilizer and reduction of environmental pollution.

In addition, the SWA has also been applied for pot test of flower plants for growth promotion and the maximum time for water stopping. The field test of SWA on several kinds of plant (tea, dragon tree, coffee, etc.) has also showed the good increase of yield by about 25% (coffee bean) compared to the control.

In future the research and application of SWA in Vietnam will be concentrate to the preparation and test of SWA using raw natural materials such as coir dust; preparation and test of SWA immobilized nutrient and PGP for widening the application scale; application of SWA for urban area; application of SWA for composting livestock excrement and agro-wastes to produce multi-functional bio-fertilizers.

**(10) Myanmar (Mr. Myo Min Thant, Department of Atomic Energy, Ministry of Science and Technology)**

In Myanmar, preparation of super water absorbent has already done on lab scale. In preparation of super water absorbent, corn starch was obtained from the commercial and was then gelatinized with water containing KOH, neutralized with acrylic acid, irradiated with gamma chamber. Finally, super water absorbent was obtained. Future research works for polymers are to study the radiation effect on the natural polymers, to produce hydrogel wound dressing from chitosan by using the gamma facility and to produce the fertilizer by chemical treatment.

**(11) Pakistan (Mr. Muhammad SHAFIQ, Pakistan Institute of Engineering & Applied Sciences)**

Currently, the hydrogels are being used as drug delivery carriers and toxic metal adsorbents from waste water in Pakistan. Such hydrogels are being prepared from the combination of natural and synthetic polymers. While 80% of the economy of our country and population depend upon the agriculture, the major land is either mountain or desert and there is a shortage of water and electricity. Therefore, it is imperative to commercialize super water absorbents (SWAs) to stimulate our agriculture. A study has been started to prepare SWAs using radiation crosslinking of polysaccharides with nanomaterials. The SWAs will be used to enhance the production of rice, maize, potato, bell pepper and flowers. Once completed the pot and field tests, the products will be registered for commercialization.

**(12) Sri Lanka (Ms.Samantha Samalatha KULATUNGE, Atomic Energy Authority)**

Sri Lanka embarked on SWA in the year 2012 and established the research group consisting of two institutions Horticultural Reseach & Development Institution (HORDI) & Field Crop Research & Development Institution (FCRDI) under the Department of Agriculture, Open University, Sri Jayawardenapura University together with the Atomic Energy Authority.

Sri Lanka carried out studies on application of SWA for urban agriculture using tomatoe as the crop. Natural Polymers such as coir dust will be used to develop SWA locally.