**Commercialization of Corn Production and Hybrid Seed Industry Development in North Korea**

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**Abstract**

This presentation suggests North Korea (NK) government to commercialize of corn (*Zea mays* L.) production as staple food, export driving seed industry and specialty corn production. The products can be used internally, export to South Korea (SK), China and Japan. Over two million tons of extra corn grain can be produced in North Korea (NK). The product could be exchanged with rice from SK. NK has comparative advantage to adapt the corn–livestock production farming system development because of favorable weather conditions. Livestock industry including piggery and poultry shall be developed strategically for a sustainable farming and the high quality animal manure production as the products uses and also exports. The livestock manure shall contribute sustainable corn production and protect environments. By breeding of super stable corn hybrids, an average yield of 8t/ha from 700,000 ha can be produced with appropriate uses of manure and additional chemical fertilizers. All crop production depends on 50% by G (genotypes) and another 50% by E (environments). China produces an average of 6.5t/ha from 40 million ha, the largest corn production country globally. South Korea ODA, Japan and US funds shall help NK’s corn production significantly that will benefit NK, SK, and Japan as well as US for the world peace. Hybrid corn seeds of China values for over 1 billion US dollars annually. NK might export seeds of very outstanding corn hybrids to China that if they can breed locally. The author suggests breeding of supersweet, high quality sticky and pop corn hybrids. The first one contains 15% of sucrose and the second one is traditional food corn. The third pop corn is very popular snack for young peoples. All three crop products that are produced under no chemical conditions can be exported to China, South Korea, Japan and other ASEAN countries. Breeding of bio-energy (ethanol) and livestock feed corn with genes of brown mid-rib (*bm*) and leafy (*LF*) corn can be also exploited. The former *bm* corn has 20% less lignin than the normal corn that can save electricity in stalk-starch-sugar-ethanol process. Bm corn increases ruminant digestibility 20%. The LF with seven extra leaves can produce considerable high stover yield for ethanol and high quality feed. In addition, medicinal black corn with very high anthocyianine chemical in the cob and grain can be bred to improve health of the people and also for the products export. For hybrid seed industry development, Dr. Corn Seeds of China may have a branch operation in Shineuijoo if we find investors and NK government meets of commercial business conditions. We welcome collaborators with funds to promote the project implementations. Agriculture can be the best option for the strategic development of NK economy with tourism. US government supports can play a vital role for the project and coordinates of US corn scientist groups for North Korea.

This NK corn commercialization project proposal suggested here may work when NK gives up nuclear program and missiles pursues peace in Korean Peninsular and final reunification of two Koreas. NK scientists have joined in the presentation and publications as co-authors of the collaborative corn research in international conferences as well as in SK (see references).

**Introduction**

This presentation suggests a dramatic food production increase of North Korea (NK) based on science and the author’s 20 years of corn breeding experiences in North Korea since 1998. The author has had a half century (50 years) environment-friendly high productive and health corn breeding in US universities and seed companies, International Agricultural Research Centers, and developing countries in Asia and Africa since 1969. Corn is the most widely grown staple food in North Korea with 700.000ha followed by rice with 600,000ha. By the invitation of NK government, the author has been tested over 50,000 crosses of corn in NK. Over 200,000 crosses have been bred and tested in China. “Suwon19” (KS5 x KS6) was the first single cross hybrid bred in Asia in 1976 after the author’s advanced studies for master and doctoral degrees at the University of Hawaii, University of Illinois, Illinois Foundation Seeds, Holden’s Foundation Seeds, Pioneer Hi-bred International and Cargill Seeds under the East-West Center (EWC) Scholarship program. “Suwon 19” had been grown 32 years in South Korea since 1977. The same hybrid has been grown in NK from 1998. It has contributed to combat hunger in NK with over 1 million tons of additional corn production annually. 1,700 cooperative farms of NK produced corn grain during 1998 – 2002 with 23% higher yield than NK’s popular hybrid Hwaseung No. 1. It confers high tolerance to northern corn leaf blight caused by *Exsorohilum turcicum*, smut, stem borer and drought with high F1 hybrid seed yield. Average seed yield is over 1 t/ha, 5 million seeds (1kg contains 5,000 seeds). The hybrid was bred for the southern Gangwon Province in 1976. The main center of “Suwon19” cultivation was Pyoungchang where the 2017 Winter Olympic was hold. Seeds of two parental lines, KS5 as seed parent and KS6 as pollen parent were gifted to NK by the South Korea government in 1998. Over 2,000 tons of hybrid seeds were produced annually from 1999. The new name of the “ Suwon19” in NK was “Kangneingi19”, it means “Corn19” in NK dialect. Another name was “Kang19”. The hybrid “Yanggangdo19” is the same hybrid. “Suwon19” or “Kang19” was very well adapted in wide regions of NK. The corn hybrid did not know Korea Peninsular division into two Koreas, South and North. The corn hybrid bred for South Gangwondo region of the Corn Belt was grown well in the north. Hilly side lands and the high temperature during the day time and low temperature during the night time were an ideal environment for corn cultivation. The entire regions of NK confer an ideal corn growing conditions. The most regions of NK have comparative advantage of corn cultivation compare to rice cultivation. The successful promotion of new hybrid corn cultivation with the introduction of soybean has been recovered the soil fertility in the most uplands since 1999. Corn after corn cultivation had destroyed NK soil for sustainable corn production. Until 1998, the NK Law did not allow to grow soybean in the upland. Average corn yield per unit area is three times higher than soybean. The government food distribution system in NK caused to produce corn because citizens wanted to get great amount of food corn instead of high quality protein soybean. Hunger was the key issue for food distribution. A farming system of corn (two year) and soybean (one year) rotation was introduced with the incentive system of 10% of soybean product, later it changed into 5%. This bonus product contributed to start with the original source of farmers’ market. Soybean paste and soy source were reproduced from 2000. Soybean milk became popular as high nutrition drink for children, pregnant women and elders. Collaborative corn program by NK and SK has bred 50,000 crosses of corn. 12 outstanding high yielding and stable hybrids were selected for ecology specific environments throughout six ecological zones. The author proposes a commercialization of corn production and seed industry promotion for economic development of NK. “One egg per child daily” promotion is suggested. “Corn-soybean livestock farming” can be a science based sustainable farming system. It can drive corn as an export and cash crop in NK. New initiative corn breeding and production of sugar corn, sticky corn, pop corn, bio energy, feed and medicine corn is also suggested by HGU, PUST, and ICF to NK government.

**Six ecological zones:**

Korea peninsular is a small country with the long south – north distance. Ecological zones of NK may be grouped into six : 1) lowland plain of West including Pyongyang, 2) south central including Hwangjoo-Yongcheon, 3) central northern region including Eunsan and Gaecheon, 4) eastern including Woonsan and Tongcheon, 5) north-west mountain region including Ganggae and Daehongdan and 6) north-east region including Bukcheong, Cheungjin and Rajin sumbong, respectively. Based on G x E technology, very high yielding hybrids with stress tolerance can be bred for respective agro ecological zones.

Table 1. Main biotic and abiotic stresses for corn cultivations in six ecological zones of North Korea.

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Ecological zones stresses How to reduce stresses Remarks

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1.Lowland plain of West Stalk rots, *turcicum*, Tolerance breeding, 2nd productive zone

including Pyongyang: , double cropping drainage

2.South central *Turcicum*, stem borer, Tolerance breeding, some year flooding

incl. HwangjooYongcheon, acid soil

Haejoo,

3.Central north *Turcicum*, stem borer tolerance breeding Most productive

incl. Eunsan, Gaecheon,

4. Eastern south *Maydis*, Grey leaf spot Tolerance breeding Difficult region,

incl. Woonsan, Tongcheon, *turcicum* Gang19 well

Gumho

5. North-west mountain Smut, *turcicum*, cold Tolerance breeding Short season

Incl. Ganggae, Daehongdan

6. North-east, *Turcicum*, smut, Tolerance breeding, Most difficult.

incl. Bookchong, Cheungjin, drought Early cultivars can be productive

Rajin sumbong.

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Source: The six ecological zones are grouped by the author’s visits and also discussion results with corn scientists in NK since 1998.

An effective corn breeding can be carried out for respective ecological zones by G x E science technology. Occurrences of biotic stresses are different for each ecological zone. Ecology specific target corn breeding can stabilize national corn production.

**Export driving corn-livestock science farming technology:**

NK has a comparative advantage for high corn production by favorable environments with good drainage soil in upland and hilly side farms. High variations of day and night temperature help corn to do effective photosynthesis. Corn –soybean – livestock farming system shall sustain production of both crops and animal production. Soybean cultivation was introduced into solid corn base upland farming in 1998 to restore soil fertility. Approximately 200,000ha of corn are cultivated in hilly side. Hilly side farming can be improved with the alley feed grasses for minimum soil erosion. Crops must be sowed in the horizontal way. Piggery and poultry industries might be the economic and suitable livestock option for sustainable corn production using high quality animal manures. Corn is main feed (stalk and low quality grain) for the two animals (pig and poultry). Ecology specific super hybrid corn breeding with tolerance to biotic (*turcicum*, smut and stem borers) and abiotic stresses (drought, cold, N deficiency) and intensive uses of animal manures shall increase corn production up to 5 million tons from the current 2.5 million tons annually. NK corn can be exchanged with SK rice that shall help economy of both the north and the south. Hybrid breeding of livestock can be also carried out for more meat and egg production with better tolerance to animal diseases. High quality meats of pig, chick and eggs without much uses of chemical injections can be popular animal products to be exported. Meats produced in highland mountain regions are better quality than those of the lowland ecology. South Korea, Japan and China are the largest meat importing countries. NK has a clear economic advantage with the minimum transportation costs for the export items. Export high quality products and import cheaper agricultural products. The export encourage government policies shall earn foreign exchanges and also more job creation. Export driving was the key government policy to achieve economic progress of South Korea, China and Japan.

**G x E corn breeding technology:**

Biotic and abiotic stresses of corn cultivation :

Corn yield depends on 50% genotype (G) and another 50% environments (E). The major biotic stresses of corn cultivation in NK are diseases (corn smut, Northern con leaf blight), insects (stem borers), drought and cold. While, lacks of chemical fertilizers and high quality seeds are two main corn production input constraints.

Stress tolerance cultivars (hybrids and OPVs) controlled by quantitatively inherited genes must be bred. This QTL (quantitative trait loci) tolerance breeding can be the best option to minimize climate change damage. Seeds of open-pollinated variety (OPV) can be reused by cooperative farms in remote areas without expensive and difficult seed production hybrid seeds. Disease tolerance OPVs can yield more than susceptible hybrid under prevalent diseases particularly *Exserohilum turcicum* (north corn leaf blight: NCLB) and *Ustilago maydis* (corn smut). The author had seen many fields of corn that were wiped out by *E. turcicum* , near Koksan region on the way to Pyongyang to Woonsan and Jeongjoo to Shineuijoo roads. NK government policy to plant only hybrid corn including the remote ecology specific zones is wrong and it must be corrected. The author-NK team bred North East corn populations with tolerance to diseases, insects, drought and cold. Yield of OPV is 80% of the best hybrid in general. In the remote regions, promotion of new cultivar of OPV has clear advantage. NCLB, smut, corn stalk borers, and drought are four major biotic stresses for stable production of corn in NK. High quality and high yielding hybrids and adequate manure and fertilizers are main inputs.

**Seed industry development:**

Values of China corn seed market accounts for one billion US dollars annually. 5,000 corn seed companies market of hybrid corn seeds in China. 90% of the companies are small. If North Korea government with the close collaboration and supervision of the author, NK may form an outstanding seed company with Dr. Corn Seeds that may provide high quality and high yielding hybrid seeds to nation-wide regions of NK and also China. Dr. Corn Seeds Co. of China may set up a branch seed office in Shineuijoo if any investors are joined or both NK and SK government fully supports. NK may ear a great money through hybrid corn seed market. Due to the many mountains, hybrid corn seed production in NK is more feasible than that in the North-East China where almost no mountains. New name of Dr. Corn Seeds is the “Heilongjiang Yuanye Seeds Co.” based in Haeroon, the black soil kingdom. If seed import and export regulation between North Korea and China is resolved, F1 seeds of the Yuanye Seeds can be produced in NK and export to China. If the same hybrids are well adapted in NK, the hybrid seeds can be used in the country. “China-Korea Corn No. 1” hybrid was selected from border towns of Shenyang and Dandong. This will be well adapted in NK. Its performance is good from Shenyang, Gongjuliang, up to Haeroon of all three North East Provinces.

During the historical floods of NK in 1996-’97, most of the valuable seeds of crop germplasms were lost (Lee, Kwangsoo of Vice President of Academy of Agricultural Sciences in Pyongyang, 1998). Seed revolution of corn hybrid started to increase purity of hybrid corn seeds from 75% to 98% in two years in 1999. The same seed revolution was employed for Irish potato (white potato). The potato is the dominated crop in mountain regions. The leader of the country, HE Kim, Jeong-IL emphasized to fill in the shortfall of foods in NK with Irish potato. The World Vision pioneered of micro tube seed potato technology in NK. Dr. Chung, Hwuek of the Bio Technology Institute in Daejeon visited NK with the author in 1998. Because of his micro seed potato technology was patented, he could not hand over the virus free potato seed technology to NK. Suggestion was made to introduce Russia’s micro tube potato seed technology that was used by the Rural Development Administration (RDA)’s Daekwanreoung institute of South Korea.

The low production of food corn hybrid in the mountain regions of NK often caused the low corn production in the mountain regions. The government regulation forced to plant only corn hybrids to all regions although susceptible cultivars could be wiped out by *E. turcicum* and smut. Biotic tolerance of corn breeding has not been effectively carried out for the remote areas. Potato seeds with hybrid corn seed technology using “Kang19” hybrid contributed much to solve devastated food situation in NK during 1998 to 2002.

The author established Dr. Corn Seed Company in Jilin Province of China registered in Shipyoung City after his visit to Sanya of Hainan Province in January, 2008. Two main aims were 1) hybrid corn seed revolution in China and 2) to help NK corn production increase and seed industry development. The environments of Sanya are similar to Hawaii of USA. This place is a paradise for hybrid corn seed breeding during winter season. China uses the Hainan province as strategic zone for hybrid corn and hybrid rice breeding during the mainland winter season. The author has bred more stable hybrids than the current Chinese ones using the winter nursery in Sanya. The author’s quantitative tolerance (co-survival genetic principle) breeding experiences of 50-year since 1969 is the key of the success. In China all corn seed companies including government provincial and local agencies are commercialized. They keep parental lines of corn hybrids as strictly confidential. Chinese government may give only seeds of parents of the pass-out hybrids, e.g, Eunsan 5 and Jeungdan 958. Hybrid corn seed industry in China is No.1 priority of the government policy. Corn is No. 1 crop in China since 2004. US Syngenta Seeds Co. was bought by a chemical company in Beijing in 2016 to secure of the most advanced parental lines and hybrid breeding technology including GMO corns.

Chinese government policy does not invite NK corn scientist after the physiological maturity of corn. Because of this, ICF with Dr. Corn Co. of China invited five corn scientists to visit of three North Eastern Provinces after Shineuijoo flood in 2010. The team visited three breeding sites of DR. Corn Seeds for one week. They were Shenyang of Lyoining Province, Gongjuliang of Jilin Province and Harbin of Heilongjiang Province. ICF invited four NK corn scientists to attend US Annual Corn Genetic Conference in Beijing in 2012. All these efforts were to promote hybrid corn seed industry development and corn production increase of NK.

**New corn breeding initiatives:**

**1.**Sugar corn, sticky corn and pop corn for children and tourists:

Sugar corn, honey corn or supersweet corn controlled by shrunken 2 gene (*sh2*) has been very popular vegetable corn in USA and Japan. The sugar corn contains of 15% sucrose that will help to improve people’s health. NK-SK super corn breeding team started sugar corn breeding in Pyongyang in 1998 with a big encouragement of HE Leader, Kim, Jeoung-IL of the country. However, the cold weather caused to make the team difficult to advance the breeding materials since 2013. The author did not visit NK for three years. With sugar corn germplasm bred for the north- eastern region of China, now breeding for sugar corn for NK region can be easier. Sugar corn ears produced in NK may export first to South Korea and Japan, and also to China with a 1/4 dollar of price per ear. Internal consumption of sugar corn can be very popular food policy of HE Chairman of Cabinet, Kim, Jeung Eun. Sticky corn is a popular food corn in Korea and China traditionally. The author works sticky corn and sugar corn as a priority breeding tasks with Heilongjiang Yuanye Food Co. in Haroon City (www: hljyysp.com), 200km north from Harbin. The Yuanye Co. is No. 2 food corn processing in China with 30 million cob production of sticky corn. This company aims to produce 100 million cobs in 2019, as the NO. 1 in China. Sticky corn shall improve staple corn food quality for NK citizens. Pop corn is other food corn to feed children. Without popping machine, pop corn can be popped easily by households. Germplasm bred in South Korea and China can be used.

2.Bio-energy and feed corn breeding: The author has been breeding of bio –energy ethanol production corn, called “Super corn + bm3 + high sugar + leafy” since 2010 under the fund support from POSCO, the largest steel company globally located in Pohang. Brown midrib 3 (*Bm3*) gene with 20% of low lignin was used to save the energy of ethanol extraction. High sugar in the stalk can increase of ethanol production. With more than 15% sucrose of stalk, an enzyme does not need to convert starch into ethanol. We found up to 22% of sucrose of corn in stalk. Average content is around 5%. In addition, leafy gene (*LF*) with seven extra leave has been incorporated into *bm* gene. The project is a difficult breeding task. The same bio corn can be used as an outstanding feed for cattle with 20% high digestibility increase of *bm* corn from the normal. Because of low lignin in the stalk *bm* hybrid causes high root lodging and reduce grain yield 20%. By the extensive corn breeding in China and Korea, the author has been solved lodging and low yield problems. This is really a research breakthrough of corn science. Leafy gene shall increase stover yield of corn as silage significantly when corn plants feed to cattle. .

3.Medicinal corn breeding: The author initiated black (*BL*) corn breeding against Food Mouth and A1 Bird Flu viruses in Sanya, in 2008. The project has been an extremely difficult subject since inheritance of black genes are not clear. In 2017, bio technology scientist, Prof. Do, Myoung-Sool team of HGU found the black cob and black grains of *BL* corn has anti-diabetic and anti-inflammatory effects in using of experiments with mice. The result of discovery was published in Korea Food Nutrition Journal in 2017. We patented the effective chemical extract and black corn breeding technology. *BL* corn may have a great potential for health beverage drink and also hub medicine products development. The author is ready to collaborate this new discovery corn breeding with NK if they are fully support of the project proposal implementation in the north.

4.Super foods: normal corn x sugar corn will provide sucrose harvested at fresh corn stage. Using super heterosis of two distinctive corns, a super food of corn may be bred to fill in the hunger gap prior to the corn grain harvest. In addition, China bred super noodle corn was confirmed of outstanding cold noodle (Neingmen) raw materials. HE Chairman of Cabinet Kim, Jeung Eun tasted this in Pyongyang two years ago. The author tasted its high quality noodle in Harbin October, 2017.

**South Korea ODA project suggested:**

Since NK is a developing country, South Korea’s ODA fund may be used to assist NK’s agricultural development in a sustainable way. SK has the obligation of uses of 300 billion Won to help the developing world. If SK government with the Assembly made a new law, to help NK by ODA fund. The fund may be used for the loan of small scale family farms for their health food crop production, similar projects have been supported in many developing countries. A million tons of rice from South Korea may be also supported to NK.

**Responsibilities of partners:**

NK Government: Her government must support for the operations of the HGU, PUST and ICF corn breeding program in NK. We may train a few students for breeding, agronomy, extension, seed production, pathology, entomology and economy. This program will train at least five breeders who will do advanced hybrid corn breeding throughout different ecological zones in NK. The ideal operation of the program can have breeding lines and hybrids testing field stations in respective ecologies, main one in Mirim Research Station in Pyongyang, and other locations such as Eunsan, Gaechon, Jeungjoo, Hwangjoo, Woonsan and Bukcheong. During the operations and project management, transportations with fuel must be provided by the NK government. Timely invitations and visas must be also guaranteed. PUST needs to arrange these with NK authority.

SK Government: To speed and implement of the HGU, PUST and ICF corn breeding program, the Ministry of Education and Ministry of Science and IT in the collaboration of the Ministry of Unification in Seoul need to finance research funds of the project (breeding and materials-pollination bags, NGO fertilizers shipment and also winter nurseries in Phnom Penh of Cambodia or Sanya of Hainan Province. Corn program of the National Food Crop Research Institute of the RDA may join the project as the joint partner. ICF fund raising shall provide fertilizers for the research and on-farm testing of the leading corn crosses and inbreeding lines that Dr. Corn Seeds and ICF-HGU selection in China. Four hybrids have been pre-selected in the north east provinces in China. They are high yielding normal field corn, supersweet corn, sticky corn and bio corn (bm + leafy). Bm3 + LF is the world first new breeding corn by Prof. Kim in South Korea and China.

HGU: Coordinating corn breeding program for North Korea and internationally. Seeking fund for the project from Ministry of Education, Ministry of Science and IT, and Ministry of Unification should be carried out.

PUST:: Train NK young students for Master Degree in the fields of crop breeding and related fields in Pyongyang. Coordinate all logistics of project management in North Korea including invitation letters from NK government. Arrange the collaborative research with the Academy of Agricultural Sciences in Pyongyang

ICF: Fund raising for NK corn breeding programs from Koreans globally and foreigners. With the helps of US universities and NGOs in Japan may speed up the project since ICF has over 10 years of experiences in NK.

Dr. Corn Seed Co. of China: May provide germplasm if NK guarantees Plant Breeders Right of the parental inbred lines of hybrids selected.

US collaborators:

Kentucky State University, Kentucky University, other agencies and NGOs may join NK staple food corn program. US government supports can play a vital role for the project and coordinates of US corn scientist groups for North Korea.

**References** (the bold is names of co-authored NK scientists at international conferences and South Korea agricultural meetings ).

Kim, Soon-Kwon. 1998-2002. Annual super corn project report of South and North Korea to the Ministry of Science and Technology in Seoul, Kyungpook National University and International Corn Foundation, South Korea.

Baker Michael (S. K. Kim). 1999.North Korea, joint projects allow a peek into an impoverished system. News Focus. Science 10 Sept. Vol 285: 1657-1658.

Kim, Soon-Kwon, 2000.Combining national efforts for combating food deficiency development of super maize. p.83 Projects around the World International - Examples of the future. Projects around the world of EXPO 2000, and p.356-357, EXPO 2000 Hannover, The World Exposition, 1 June- 31 Oct., 2000, Germany.

Kim, Soon-Kwon, 2002. Development of super-corn in North Korea by the collaboration of South and North Korea as a model effort for Korea's unification. Roundtable for Knowledge Cooperation with the DPRK. KDI School of Public Policy and Management, March 18-20, 2000, Seoul, Korea.

Kim, S. K. 2003. Development of super-sweet and sweet corn research in South and North Korea. International Sweet Corn Research and Development Association Conference, Kauai, Hawaii, USA, Feb.20-22.

Kim. Soon-Kwon, **Kwang-Soo Lee, Hyung-Jai Han, Park Kim,** Hyung-Wook Kim, Joon-Soo Lee, Young-Hwan Kim, Kyung-Gun Jo, Hwang-Gi Min and Myoung-Hoon Lee.2004. Combating hunger in North Korea through super-corn development and science-based sustainable farming system. P. 167. Handbook and Abstracts.4th International Crop Science Congress, in conjunction with 5th Asian Crop Science Conference and 12thAustralian Agronomy Conference. 26 Sept.-1 Oct., Brisbance Convention & Exhibition Centre, Queensland, Australia. <http://www.cropscience.org.au/icsc2004/poster/2/3/375_kimsk.htm>. bold names are NK scientists.

Kim, Soon-Kwon, **Hyungjai Han, SunHwak Kim, Kyungchul Park**, Hyungwook Kim, Joon-Soo Lee.2004. Genetic studies of *Exserohilum turcicum* resistance of corn in diallel crosses at two locations in North Korea. p.280-281 (PO88). Abstracts, Autumn Annual Meeting, Korean J. of Crop Science(Vol. 49 Suppl.2), hold at the Kyungpook National Univ. Daegu, Korea, Oct. 21-23. Bold names are NK scientists.

Kim, Soon-Kwon, **HyoungJai Han, Park Kim, Kwangsoo Lee, Kyungsik Lee**, Hwanggi Min, Myounghwak Huh, Yaeran Gong, SeoungHwan Choi, Hyungwook Kim, and JoonSu Lee. **2004.** Testings of 34 corn hybrids bred for North Korea by South and North joint project at five stations in China. p.282-283 (PO89). Abstracts, Autumn Annual Meeting, Korean J. of Crop Science (Vol.49 Suppl. 2), hold at the Kyungpook National Univ. Daegu, Korea, Oct. 21-23. Bold names are NK scientists.

Kim, Soon-Kwon. 2007. Livestock industry development of South and North Korea and super silage corn breeding. An International Seminar on livestock development in North Korea. Kunguk University, Seoul, Korea, Dec., 6, 2007.

Kim, Soon-Kwon, 2010. A scientist battles for peace – his weapon is food. Handong Global University. A document submitted to the nomination of Nobel Peace Prize. 66PP.

Kim, S. K., H. W. Kim and J. S. Lee. 2012. Tolerance expression of maize genotypes to *Exserohilum turcicum* in North and South Korea. Korean J. of Crop Science 57(2): 113-126.

Kim, Soon-Kwon. 2013. Global effects of co-survival tolerance principle discovered by Dr. Soon-Kwon Kim. A document submitted to the Nobel Physiology or Medicine Prize by the Former President of Duke University.

Kim, S. K. 2014. Six-year of genetic vulnerability of hybrid corn breeding in China, the 56th US

Annual Maize Genetic Conference hold in Beijing, March 13-16.

Kim, Soon-Kwon. 2016. A decade experiences of genetic vulnerability of corn cultivation in China and its application of hybrid corn breeding. BIT’s 7th World Gene Convention- 2016, Sharaton Shanghai Waigaoqiao Hotel, China P.308.

Kim, Soon-Kwon. 2017. A half century experiences of co-Survival tolerance principle in maize and its application combating *Striga*  in Africa. BIT’s 2nd International Congress of Genetics –April 25-27, 2017, Hilton Hotel, Xi’an, China,

Kim, S. K. 2017. A review of a half century hybrid maize breeding experiences with combined tolerance to major biotic and abiotic stresses in China and other developing countries. Universal Journal of Agricultural Research 5(5):288-295.

Joung, Hyunchae, Chai-hee Kim, Yejoo Lee, Soon-Kwon Kim and Myoung-Sool D. 2017. Anti-diabetic and anti-inflammatory effects of purple corn extract in high-fat diet induced obesity mice. Korea J. of Food Nutrition, Vol.30, No.4: 696-702.