Padi untuk Ketahanan Pangan

Pusat Penelitian dan Pengembangan Tanaman Pangan
International Rice Research Institute
2010

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Bogor: Pusat Penelitian dan Pengembangan Tanaman Pangan -
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Pengantar

Pemerintah Indonesia menaruh perhatian besar terhadap upaya pemenuhan kebutuhan pangan penduduk yang terus meningkat. Dukungan kuat bagi kegiatan penelitian telah menghasilkan informasi dan inovasi teknologi produksi padi yang telah memberikan kontribusi dalam peningkatan produksi beras nasional.

Badan Litbang Pertanian dan IRRI memiliki kepentingan bersama dalam penelitian padi, terutama dalam menghasilkan inovasi teknologi guna mempercepat upaya pengembangan sistem pertanian berbasis peningkatan produksi mendukung ketahanan pangan nasional.

Tantangan besar produksi padi dewasa ini adalah perubahan iklim, semakin terbatasnya sumberdaya lahan dan air, meningkatnya populasi hama dan penyakit tanaman. Lebih dari 30 tahun kerja sama penelitian dengan IRRI, Badan Litbang Pertanian telah menghasilkan berbagai teknologi padi yang diharapkan dapat membantu meningkatkan produksi beras secara berkelanjutan.

Saat ini, varietas padi toleran rendaman dan kekeringan sedang dikembangkan melalui program Consortium for Unfavourable Research Environment (CURE) dan *Green Super Rice*, yang diharapkan Indonesia dapat meraih kembali swasembada beras. Diupayakan pula meningkatkan gizi beras bagi konsumen, termasuk beras kaya besi, seng, dan padi emas (Golden Rice) yang mengandung provitamin A tinggi. Selain itu, beberapa teknologi produksi padi juga telah dihasilkan.

Publikasi ini menyajikan secara singkat hasil kerja sama penelitian Badan Litbang Pertanian dengan IRRI. Kepada semua pihak yang telah berkontribusi dalam penelitian dan pengembangan padi disampaikan penghargaan dan terima kasih.

Bogor, Desember 2010

Kepala Pusat Penelitian dan
Pengembangan Tanaman Pangan

Dr. Hasil Sembiring

Daftar Isi

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Perpadian Nasional dan Tantangan Ke Depan

Indonesia, dengan jumlah penduduk 237 juta jiwa pada tahun 2010, merupakan negara berpenduduk terpadat keempat di dunia. Dengan laju peningkatan penduduk 1,5% per tahun, pemerintah dituntut untuk terus berupaya memenuhi kebutuhan beras yang merupakan makanan pokok di Indonesia.

Dalam periode 2007-2010, produksi padi nasional rata-rata 61,9 juta ton per tahun dengan luas panen 12,6 juta hektar. Meski pangsa beras terhadap pendapatan petani relatif rendah, peranan beras tetap strategis karena mempengaruhi stabilitas ekonomi dan politik. Apabila harga beras naik 5-10%, misalnya, tingkat inflasi turut meningkat. Dalam periode 2006-2009 konsumsi beras sedikit menurun, konsumsi umbi-umbian menurun 6%, sayuran dan buah-buahan meningkat 6%, unggas 9%, dan gandum 10% per kapita per tahun. Dalam kondisi krisis ekonomi pada tahun 2009, konsumsi beras per kapita relatif menurun dibandingkan dengan bahan pangan lainnya.

Sebagai komoditas strategis, padi tetap memerlukan prioritas yang tinggi dalam peningkatan produksinya. Hal ini tercermin dari program pembangunan pertanian di Indonesia dengan empat target: (1) pencapaian swasembada beras dan swasembada pangan berkelanjutan, (2) peningkatan diversifikasi pangan, (3) peningkatan nilai tambah, daya saing, dan ekspor, dan (4) peningkatan kesejahteraan petani.

Hingga saat ini sistem ketahanan pangan nasional masih bertumpu pada produksi padi, sehingga upaya peningkatan produksi komoditas strategis ini akan tetap mewarnai pembangunan pertanian ke depan. Di sisi lain, upaya peningkatan produktivitas padi perlu disejalankan dengan upaya peningkatan efisiensi tenaga kerja, sarana produksi, dan pelestarian sumber daya alam.

Tantangan bagi penelitian adalah bagaimana meningkatkan pasokan pangan secara terus-menerus dalam kondisi lahan dan air yang terbatas, sementara sumber daya alam perlu terus dilestarikan.

IRRI yang didirikan pada tahun 1960 oleh Rockefeller dan Ford Foundation bertugas melakukan penelitian guna membantu negara-negara berkembang dalam meningkatkan produksi padi. IRRI adalah salah satu dari 16 pusat penelitian pertanian internasional yang didukung oleh Consultative Group on International Agricultural Research (CGIAR). Pendekatan antardisiplin ilmu didasarkan pada kerja sama yang erat antarlembaga penelitian dan penyuluhan pertanian di seluruh dunia.

Melalui kerja sama, peneliti berupaya menggali berbagai inovasi, antara lain dampak intensifikasi terhadap kelestarian sumber daya lahan, meningkatkan pemahaman terhadap pengelolaan hama penyakit tanaman, dan menimba wawasan baru tentang dampak perubahan iklim global.

Data perpadian Indonesia

Uraian	Nilai
Jumlah penduduk, 2010	237.556.000
Pertumbuhan populasi 10 tahun terakhir (%)	1,49
Pendapatan nasional bruto (US$), 2009	2.230
Populasi penduduk perdesaan (%), 2009	47 (109.049.272)
Harapan hidup (tahun)	71
Total jumlah petani (tenaga kerja/buruh tani), 2009	39.389.442
Total luas area pertanaman padi ('000 ha)	7.790
Rata-rata hasil padi (t/ha beras giling) 2009	5,0
Total produksi padi (ton), 2009	64.398.890
Luas panen padi (ha), 2009	12.883.576
Jumlah penyuluh di Indonesia, 2008	28.879
Konsumsi beras (juta ton)	38,9
Ongkos produksi untuk 1 ha sawah	Rp 4.000.000 (US$430)
Konsumsi beras per kapita per tahun (kg)	139

Sumber: FAOSTAT; Bank Dunia, dan BPS

Keberhasilan Meningkatkan Produksi

Upaya untuk mencapai ketahanan pangan nasional dimulai pada tahun 1960-an yang diawali dengan Lima Tahun Pertama Program Pembangunan Nasional. Hal ini didukung oleh kemauan politik yang kuat dari pemerintah. Pembangunan infrastruktur mendapat prioritas utama, antara lain pembangunan jaringan irigasi dan industri pupuk, termasuk peningkatan kemampuan peneliti dan penyuluh pertanian.

Setelah lima tahun menjalankan program intensifikasi, Indonesia berhasil mencapai swasembada beras pada tahun 1984. Sebagai negara dengan populasi penduduk terpadat keempat di dunia, Indonesia memerlukan pangan dalam jumlah yang besar. Dalam periode 2007-2010 produksi padi nasional meningkat menjadi rata-rata 60,6 juta ton dari 12,3 juta hektar luas panen, dengan laju peningkatan 5% per tahun, 2,5% di antaranya berasal dari peningkatan produktivitas (Tabel 1). Hal ini mencerminkan penerapan inovasi teknologi yang dihasilkan melalui penelitian memegang peranan penting.

Peningkatan produksi padi nasional dewasa ini tidak dapat dilepaskan dari pengembangan varietas unggul dan teknologi pemupukan secara luas. Hal ini sejalan dengan upaya pemerintah dalam mendorong petani untuk mengadopsi teknologi padi melalui program Sekolah Lapang Pengelolaan Tanaman Terpadu (SL-PTT). Melalui program ini pemerintah memberikan subsidi pupuk dan benih kepada petani. Kemampuan penyuluh pertanian dalam pengembangan teknologi ditingkatkan pula melalui pelatihan SL-PTT pada berbagai tingkatan.

Tabel 1. Areal panen, produktivitas, dan produksi padi di Indonesia, 2007-2010

Uraian	2007	2008	2009	2010*
Luas panen (ha)	12.147.637	12.327.425	12.883.576	13.118.120
Produktivitas (t/ha)	4,705	4,894	4,995	5,030
Produksi (t)	57.157.435	60.325.925	64.398.890	65.980.670
Pertumbuhan luas panen/tahun (%)	3,06	1,48	4,47	1,86
Pertumbuhan produktivitas/tahun (%)	1,84	4,02	2,07	0,60

Sumber: BPS, 2010. * Data tahun 2010 adalah angka ramalan III

Kerja sama Badan Litbang Pertanian – IRRI

Pemerintah Indonesia menekankan pentingnya penelitian dan teknologi dalam mendukung pembangunan nasional. Penelitian kolaboratif di dalam dan luar negeri mendapat perhatian khusus, dan lembaga penelitian padi nasional telah menjalin kerja sama dengan lembaga penelitian di luar negeri, terutama International Rice Research Institute (IRRI).

Kolaborasi antara pemerintah Indonesia dan IRRI dimulai pada 20 Desember 1972. Enam tahun kemudian, nota kesepahaman (MoU) kerja sama antara kedua pihak ditandatangani oleh Direktur Jenderal IRRI dan Kepala Badan Penelitian dan Pengembangan Pertanian.

Kerja sama memberikan prioritas yang tinggi terhadap evaluasi dan pemanfaatan sumber daya genetik padi dalam meningkatkan produksi, pengembangan dan pengujian mesin pertanian skala kecil, pendidikan formal dan pelatihan nongelar bagi peneliti Indonesia. Pada tahap awal, kerja sama mendapat dukungan dari berbagai pihak, antara lain Ford Foundation, United State Agency for International Development, Japan International Cooperation Agency, dan Pemerintah Belanda.

MoU berikutnya ditandatangani pada 30 Agustus 1984, dengan fokus evaluasi dan pemanfaatan sumber daya genetik padi pada berbagai ekosistem, terutama lahan dataran tinggi dan lahan rawa pasang surut. Dalam hal ini mencakup kolaborasi pengelolaan air, pertukaran sumber daya genetik, peneliti, dan publikasi bersama.

Kantor IRRI Perwakilan Indonesia menempati bagian Kantor Puslitbang Tanaman Pangan di Jalan Merdeka 147, Bogor, 16111, Indonesia

Sebagai pengakuan terhadap peranan IRRI dalam membantu Indonesia mencapai swasembada beras pada tahun 1980an, Presiden RI pada tahun 1989 menganugerahkan Bintang Jasa Utama, penghargaan tertinggi negara kepada Direktur Jenderal IRRI.

MoU berikutnya, masing-masing berlaku untuk jangka waktu lima tahun, telah ditandatangani pada April 1990, November 1995, Desember 1999, Juni 2001, dan September 2006. Fokus kerja sama mencakup berbagai aspek pengembangan sumber daya penelitian. Evaluasi, pengelolaan, dan pemanfaatan sumber daya genetik padi untuk berbagai ekosistem tetap menjadi prioritas utama. Selain itu, kerja sama juga menekankan pentingnya peramalan epidemi hama dan penyakit tanaman padi, meningkatkan kualitas tanah, dan promosi inovasi teknologi.

Pertemuan terakhir rencana kerja Badan Litbang Pertanian-IRRI dilaksanakan di Jakarta pada bulan Maret 2007. Dalam pertemuan disepakati bahwa untuk tiga periode 2007-2009, Indonesia dan IRRI akan fokus kepada topik kerja sama penelitian berikut:

A. Dukungan terhadap Program Peningkatan Produksi Padi

    (1) Padi Tipe Baru dan pemuliaan yang lebih maju untuk potensi hasil tinggi, mutu gabah, dan ketahanan terhadap hama.

Penandatanganan MoU kerja sama penelitian Badan Litbang Pertanian dengan IRRI di Los Banos, Filipina, September 2006

(2) Strategi nasional dan rencana pengembangan padi hibrida.

(3) Toleransi tanaman padi terhadap rendaman, kekeringan, dan suhu rendah di dataran tinggi.

(4) Dukungan terhadap implementasi PTT padi di wilayah sasaran melalui IRRC dan *Rice Knowledge Bank*.

(5) Penyebaran teknologi pascapanen.

B. Kerja Sama Penelitian

(1) Penguatan kapasitas penelitian dalam pengembangan padi transgenik di Indonesia.

(2) Peningkatan kualitas gabah dan nilai gizi beras, termasuk dukungan pengembangan laboratorium mutu gabah Kementerian Pertanian.

(3) Genomik fungsional dan pemuliaan molekuler, dengan penekanan pada toleransi terhadap kekeringan, pengendalian penyakit blas, dan defisiensi hara P.

(4) Pengembangan teknologi budi daya tanam benih langsung dan irigasi hemat air.

(5) Penguatan hubungan antara penelitian dan pengembangan: inisiatif untuk mempercepat adopsi teknologi melalui *Rice Knowledge Bank*.

(6) Penguatan kerja sama dan kapasitas dalam sosio-ekonomi, pengkajian dampak, dan studi kebijakan.

(7) Penelitian perubahan iklim (dampak iklim dan kerentanan, padi toleran kekeringan, padi umur genjah).

(8) Pengembangan indikator keanekaragaman hayati, kelestarian lingkungan, dan mengkaji multifungsi sistem produksi padi.

(9) Perbaikan manajemen kanopi "sehat" untuk hasil tinggi.

C. Pengembangan Sumber Daya Manusia

(1) Pelatihan *sandwich* program untuk tingkat pascasarjana

(2) *Shuttle scientist*

(3) Magang (*on-the-job training*)

(4) Pertukaran peneliti

(5) Pelatihan jangka pendek

(6) Pelatihan dalam negeri.

Sumber Daya Genetik

Pertukaran bahan genetik dimungkinkan melalui Jaringan Internasional untuk Evaluasi Genetik Padi (INGER), kemitraan yang sudah berlangsung selama 35 tahun antara penelitian pertanian nasional di negara-negara penghasil padi di seluruh dunia dan pusat-pusat penelitian pertanian internasional seperti IRRI.

INGER adalah sebagai model dalam pertukaran, evaluasi, pelepasan, dan penggunaan sumber daya genetik. Jaringan kerja sama ini mematuhi perjanjian internasional mengenai perjanjian kerja sama dan pertukaran sumber daya genetik secara terbuka.

Bekerjasama dengan lembaga penelitian nasional di banyak negara, IRRI telah mendirikan International Rice Gene Bank, yang mengoleksi dan menyimpan lebih dari 110.000 aksesi plasma nutfah padi. Seperti disepakati dalam konvensi awal, para peneliti di seluruh dunia memiliki akses ke tempat penyimpanan plasma nutfah padi ini.

Dalam periode 1970-1999 Badan Litbang Pertanian telah mengumpulkan 11.700 aksesi padi lokal, yang terdiri atas 8.851 aksesi padi dataran rendah,

Duplikat dari koleksi plasma nutfah padi Indonesia disimpan di IRRI untuk membantu pelestarian varietas lokal seperti Rojolele dan Pandanwangi

2.134 aksesi padi dataran tinggi, dan 735 aksesi padi rawa pasang surut. Dari seluruh aksesi tersebut, 9.034 di antaranya merupakan jenis indica dan 1.686 jenis javanica.

Dalam kurun waktu 1995-1999, Badan Litbang Pertanian dan IRRI mengumpulkan 592 aksesi padi yang telah dibudidayakan dan enam spesies padi liar dari berbagai lokasi, termasuk Kalimantan Tengah, Nangroe Aceh Darussalam, Nusa Tenggara Timur, Maluku, Sulawesi, dan Papua. Untuk mengelola sumber daya genetik ini telah dilakukan pelatihan bagi teknisi setempat.

Ke depan, lembaga penelitian pertanian nasional didorong untuk menggali potensi padi lokal dalam perakitan varietas unggul baru.

Varietas Unggul

Penggunaan varietas unggul, pupuk, dan pengairan tanaman telah memberikan kontribusi nyata terhadap peningkatan produksi beras nasional. Dalam periode 1970-2010, hasil padi di Indonesia meningkat lebih dua kali lipat, dari 2,35 t/ha pada tahun 1970 menjadi 5,03 t/ha pada tahun 2010.

Selain memiliki potensi hasil tinggi, varietas unggul yang dihasilkan juga berumur pendek 105-115 hari, 45-65 hari lebih genjah dari varietas lokal yang umumnya berumur 150-180 hari. Hal ini memungkinkan petani meningkatkan intensitas tanam pada ekosistem irigasi melalui pola padi-padi-padi, padi-padi-jagung/kedelai, atau pola tanam intensif lainnya guna meningkatkan pendapatan. Manfaat penting lainnya dari penggunaan varietas unggul adalah ketahanannya terhadap hama dan penyakit, sehingga memungkinkan bagi petani untuk menekan penggunaan pestisida kimia yang diketahui dapat mencemari lingkungan.

Sepanjang kurun waktu 1967-2009, Indonesia telah melepas lebih dari 250 varietas padi, yang terdiri atas padi sawah irigasi, padi ketan, padi hibrida, padi tipe baru, padi gogo, dan padi rawa pasang surut. Di Indonesia, pemuliaan padi ditangani oleh Balai Besar Penelitian Tanaman Padi (BB Padi), Badan Tenaga Atom Nasional (BATAN), Lembaga Ilmu Pengetahuan Indonesia (LIPI), dan Perguruan Tinggi. Dari sekitar 250 varietas yang dilepas di Indonesia, 62 di antaranya berasal dari galur IRRI, dan sisanya dirakit menggunakan bahan genetik IRRI sebagai tetua dan dikembangkan oleh pemulia padi Indonesia. Sekitar 70-80% dari varietas padi yang ditanam petani Indonesia, salah satu tetuanya berasal dari galur IRRI.

Tahan hama wereng coklat. Sebelum terjadi ledakan hama wereng batang coklat (WBC) pada pertengahan tahun 1970an, varietas Pelita 1-1 mendominasi areal pertanaman padi di Indonesia. Sementara itu pemulia IRRI telah menghasilkan varietas IR26, IR30, dan IR32 yang terbukti tahan terhadap WBC biotipe 1 dan kemudian menggantikan varietas Pelita 1-1 di lapangan. Varietas IR36, yang tahan terhadap WBC biotipe 2, dilepas pada tahun 1978 dan mendominasi areal pertanaman padi hingga akhir tahun 1980-an. Setelah dilepas pada tahun 1980, varietas Cisadane, rakitan pemulia Indonesia, yang memiliki kualitas lebih baik dan hasil yang lebih tinggi daripada IR36, mendominasi sebagian areal pertanaman padi hingga akhir tahun 1980an.

Varietas IR64 mendominasi areal pertanaman padi di Indonesia setelah dilepas pada tahun 1986 karena memiliki mutu beras yang lebih baik dan umur tanaman lebih pendek. IR64 masih populer sampai sekarang, tetapi beberapa laporan terbaru menyebutkan varietas ini rentan terhadap penyakit virus tungro dan hama WBC. Dewasa ini, varietas unggul nasional seperti Ciherang dan Inpari populer di kalangan petani.

Gambar 1. Peneliti IRRI, Dr. K.L. Heong (Entomologist) dan Dr. Finbarr Horgan, memberikan seminar keragaman hayati, jasa ekosistem, dan pengelolaan wereng coklat secara berkesinambungan, dan ketahanan tanaman terhadap serangga hama, 30 Agustus 2010 di Puslitbang Tanaman Pangan

Untuk mengantisipasi ledakan hama WBC perlu dikembangkan strategi pengendalian berkelanjutan berikut:

- Memahami keputusan petani dalam pengelolaan hama, sikap, keyakinan, dan praktik pengendalian.
- Memahami dampak pergiliran varietas padi terhadap hama wereng dan adaptasi varietas unggul baru.
- Mengembangkan perekayasaan ekologi dan strategi peningkatan keanekaragaman hayati arthropoda pada ekosistem padi.
- Memahami hubungan antara hama WBC, penyakit virus, dan ekologi untuk pengembangan strategi pengendalian vektor, yang menularkan penyakit virus.
- Memonitor resistensi insektisida menggunakan metode toksikologi standar dan memahami respon populasi WBC terhadap penyemprotan insektisida dan keanekaragaman hayati arthropoda lokal yang terkena dampak.

Tahan penyakit utama. Struktur populasi penyakit hawar daun bakteri (HDB) di Jawa dan Bali telah diidentifikasi melalui analisis DNA-sidik jari menggunakan panjang fragmen restriksi IS1113 penanda polimorfisme. Gen padi yang memiliki ketahanan terhadap populasi dominan HDB juga telah ditemukan, yaitu gen resesif xa-5 dan gen dominan-Xa 7 dan Xa-21. Gen tersebut dibawa oleh gen isogenic umum ke dalam strain IRRI IRBB5, IRBB7, dan IRBB21. Perbaikan ketahanan varietas IR64 terhadap HDB melalui penggabungan gen xa-5 dan Xa-7 dengan metode silang balik telah menghasilkan galur Bio 1 dan Bio 2, yang kemudian dilepas sebagai varietas Angke dan Conde pada tahun 2001. Conde (Bio 9-BC5-MR-4-5-KN-5-1) adalah hasil persilangan antara IR64*6 dan IRBB7, dan Angke (Bio 8-BC5-MR-3-5-2.PN-1) merupakan hasil persilangan antara IR64*6 dan IRBB5.

Pada agroekosistem lahan kering telah diidentifikasi struktur populasi cendawan blas (*Pyricularia grisea*) di lima lokasi, yaitu Sitiung (Sumatera Barat), Palembang (Sumatera Selatan), Tamanbogo (Lampung), Sukabumi, dan Garut (Jawa Barat). Penelitian melanjutkan penggabungan gen ketahanan blas ke dalam varietas padi melalui metode persilangan ganda menggunakan tanaman generasi kelima.

Gambar 2. Beras biasa (kiri), dan *Golden Rice* (kanan)

Nutrisi. Kebanyakan penduduk di Asia, termasuk Indonesia, kekurangan vitamin A, zat besi (Fe), dan seng (Zn). Penelitian juga diarahkan untuk merakit varietas padi yang mengandung komponen gizi tersebut.

Kekurangan vitamin A pada manusia dapat menyebabkan kebutaan. Pemberian vitamin A secara oral dihadapkan kepada masalah kurangnya infrastruktur pendukung. Oleh karena itu diperlukan cara lain untuk mendistribusikan konsumsi vitamin A, terutama kepada anak-anak. Salah satu terobosan yang dapat dilakukan untuk mengatasi masalah itu adalah merakit varietas padi yang mengandung betakaroten (provitamin A) pada gabah (endosperm). Hal ini penting artinya mengingat beras merupakan makanan pokok sebagian penduduk dunia.

BB Padi bekerjasama dengan IRRI mengembangkan varietas unggul *Golden Rice* di Indonesia, membuat persilangan awal Golden Rice 2 (GR2-R) dengan varietas yang paling disukai konsumen. Setelah menghasilkan *Material Transfer Agreement*, IRRI akan mengintroduksikan galur hasil persilangan tersebut ke BB Padi. Dalam kaitan itu, IRRI akan mendanai pembangunan rumah kaca transgenik, renovasi, dan perbaikan laboratorium padi transgenik di Kebun Percobaan Muara, Bogor.

Padi hibrida. Padi hibrida yang telah memberikan kontribusi nyata bagi ketahanan pangan di Cina dalam 25 tahun terakhir, menginspirasi negara-negara lain untuk mengembangkan komponen teknologi ini. BB Padi bekerjasama dengan IRRI mengambil inisiatif untuk menghasilkan padi hibrida yang cocok untuk daerah tropis. Pengembangan padi hibrida dewasa ini mencapai 1,0 juta ha di India, 0,3 juta ha di Vietnam, 0,3 juta ha di Filipina, dan 50 ribu ha di Bangladesh.

Pada tahun 2002, melalui kerja sama Badan Litbang Pertanian dan IRRI telah diidentifikasi dua padi hibrida yang potensial, yaitu IR58025A/BR827 dan IR58025A/IR53942, yang dilepas masing-masing dengan nama Rokan dan Maro. Kemudian, empat varietas lainnya yang dihasilkan oleh Badan Litbang Pertanian menggunakan galur IRRI sebagai salah satu tetuanya, antara lain Hipa 3 sampai Hipa 11 yang dilepas pada tahun 2004-2009 (Tabel 3). Hingga

Tabel 2. Varietas padi hibrida yang dilepas di Indonesia

Nama varietas	Tetua betina	Asal	Tetua jantan	Asal	Tahun dilepas
Maro	IR58025A	IRRI	IR53942	IRRI	2002
Rokan	IR58025A	IRRI	BR827	Bangladesh	2002
HIPA3	IR58025A	IRRI	MTU9992	Introduksi	2004
HIPA4	IR58025A	IRRI	MTU9992	Introduksi	2004
HIPA5 CEVA	IR58025A	IRRI	BR168	Bangladesh	2007
HIPA6 JETE	IR58025A	IRRI	B8049F	BB Padi	2007
HIPA7	IR58025A	IRRI	IR40750	IRRI	2009
HIPA8 PIONER	IR58025A	IRRI	BP51	BB Padi	2009
HIPA9	IR58025A	IRRI	S4325D	BB Padi	2009
HIPA10	IR68897A	IRRI	BIO-9	BB Padi	2009
HIPA11	IR68897A	IRRI	IR40750	IRRI	2009

tahun 2010, lebih dari 30 varietas padi hibrida dilepas di Indonesia, sebagian besar berasal dari Cina setelah melalui pengujian di lapangan. Padi hibrida yang sudah dikembangkan perlu disempurnakan agar memiliki ketahanan terhadap hama wereng coklat, penyakit tungro, dan HDB.

Antisipasi Perubahan Iklim

Perubahan iklim telah memicu terjadinya ancaman kekeringan pada musim kemarau dan banjir pada musim hujan. Varietas padi yang diperlukan untuk menghadapi perubahan tersebut adalah yang memiliki toleransi terhadap kekeringan dan rendaman. Persaingan penggunaan air untuk keperluan irigasi, rumah tangga, dan industri menuntut perlunya efisiensi penggunaan air untuk budi daya tanaman.

Green Super Rice **(GSR).** Padi GSR mampu memberikan hasil tinggi dan stabil dengan masukan rendah (air, pupuk, dan pestisida). Galur ini tahan dan toleran terhadap:

- Kekeringan, salinitas, dan alkalinitas.
- Penyakit blas, hawar daun bakteri, hawar pelepah daun, virus, dll.
- Hama wereng batang coklat, penggerek batang.
- Efisien dalam penggunaan air dan hara (N, P).

Gambar 3. Pertanaman padi varietas Inpari 13 pada petak demontrasi Peringatan HPS ke-30 di Kebun Inti, Puyung, Lombok Tengah, Nusa Tenggara Barat, Oktober 2010

Padi toleran kekeringan. Kekeringan sering mengancam tanaman padi pada lahan sawah tadah hujan, khususnya pada musim tanam kedua, atau musim kemarau. Oleh karena itu, petani mengusahakan padi gogorancah atau *dry-seeded rice*, diikuti oleh padi walik jerami tanpa olah tanah pada musim tanam kedua. Praktik ini memungkinkan tanam lebih awal pada musim kedua, dengan harapan tanaman dapat terhindar dari kekeringan selama musim kemarau. Satu galur telah dilepas pada tahun 2009 dengan nama Inpari 13. Varietas ini toleran kekeringan dan tahan hama wereng coklat.

Padi toleran rendaman. Lebih dari 300.000 ha lahan sawah rusak akibat banjir setiap tahun. Penanaman varietas toleran rendaman seperti Inpara 3 (IR70213-9CPA-12-UBN-2-1-3-1) yang dilepas pada tahun 2008, Inpara 4 (Swarna-Sub1) dan Inpara 5 (IR64-Sub1) masing-masing dilepas pada 2009 dapat meminimalisasi dampak banjir, karena ketiga varietas toleran terhadap rendaman hingga 14 hari.

Indonesia memiliki pengalaman dalam merakit paket teknologi padi dengan komponen teknis dan ekonomi. Berdasarkan pengalaman itu, dewasa ini dikembangkan teknologi budi daya padi dengan pendekatan pengelolaan tanaman terpadu (PTT) untuk meningkatkan produksi. Dalam hal ini direkomendasikan satu atau beberapa komponen teknologi spesifik lokasi.

Dalam upaya pengembangan PTT, pada periode 2008-2010 diperluas Sekolah Lapang (SL) PTT padi sawah irigasi hingga mencapai dua juta ha. Setiap unit SL-PTT terdiri atas 24 ha lahan petani dan 1 ha lahan sawah yang dikelola sebagai laboratorium lapangan, yang merupakan tempat pembelajaran bagi petani dalam menentukan teknologi yang akan dikembangkan.

Pengelolaan Hara Spesifik Lokasi

Pengurangan subsidi pupuk meningkatkan pengeluaran petani sebesar 25-30%. Hal ini menuntut petani untuk lebih efisien dalam penggunaan pupuk. Bekerjasama dengan Puslitbang Tanaman Pangan, BBSDLP, BB Padi, dan BBP2TP, IRRI telah menghasilkan inovasi pengelolaan hara spesifik lokasi (PHSL).

Dalam implementasinya di lapangan, PHSL diformulasikan dalam bentuk perangkat lunak PuPS-versi 1.0 (*nutrient manager for rice*). Perangkat lunak ini diperuntukkan bagi penyuluh pertanian. Implementasi PuPS secara luas memerlukan pelatihan terpadu antara peneliti, penyuluh, dan petani. Bagan warna daun (BWD) dan peralatan uji tanah diintegrasikan untuk membantu petani mengetahui takaran dan jenis pupuk yang tepat, sesuai kebutuhan tanaman padi.

Teknologi Pengairan Basah Kering

Pengairan basah kering adalah salah satu sistem pengairan hemat air pada tanaman padi sawah. Dalam sistem ini, sawah diairi untuk 3-5 hari, air cukup membasahi permukaan tanah, dan kemudian dibiarkan kering selama 2-4 hari sebelum diairi kembali. Dibandingkan dengan pengairan secara terus-menerus, pengairan basah kering dapat menghemat penggunaan air irigasi 15-30% tanpa menurunkan hasil padi. Penanaman varietas toleran kekeringan memperpanjang interval pengeringan sehingga lebih banyak air yang dapat dihemat.

Cara praktis dalam membantu keberhasilan implementasi sistem pengairan basah kering adalah memantau kedalaman air di sawah dengan pipa paralon yang dilubangi. Setelah diairi, kedalaman air di sawah secara bertahap akan berkurang sejalan dengan perjalanan waktu. Bila tinggi air (diukur dalam pipa) 15 cm di bawah permukaan tanah, maka lahan digenangi dengan ketinggian air sekitar 5 cm. Pada fase berbunga, satu minggu sebelum dan setelah tanaman berbunga, ketinggian air dipertahankan 5 cm di atas permukaan tanah, agar tanaman padi terhindar dari kekeringan.

Ambang batas kedalaman air di lahan sawah adalah 15 cm. Dalam kondisi ini pengairan basah kering tidak menurunkan hasil gabah sepanjang perakaran tanaman padi dapat menyerap air tanah di sekitar perakaran. Pipa air berlubang yang dipasang di lapangan membantu petani untuk mengetahui potensi air irigasi yang tidak terlihat di permukaan.

Gambar 4. Pipa paralon yang digunakan (kiri), cara menanamkan pipa tersebut ke tanah (tengah), dan cara mengukur kedalaman air di dalam pipa paralon (kanan)

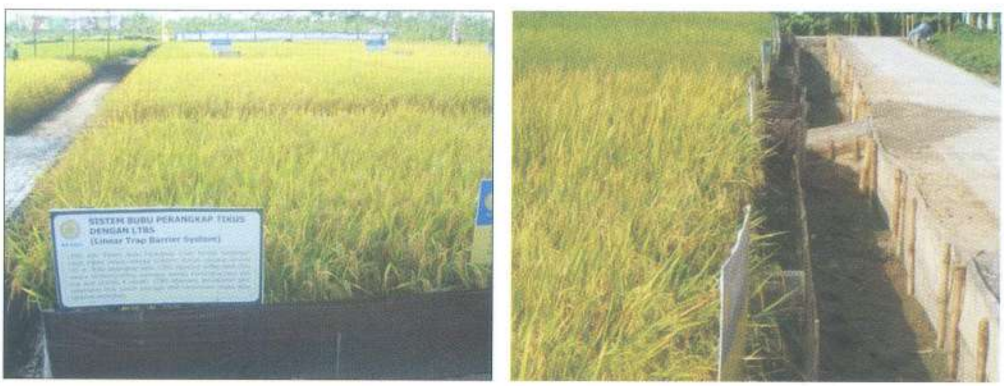
Pengendalian Hama Tikus

Hama tikus yang seringkali merusak tanaman padi tidak hanya memakan gabah sebelum dan setelah panen, tetapi juga membawa penyakit bagi manusia. Kerugian yang ditimbulkan oleh tikus pada pra-panen padi sekitar 5% di Malaysia dan hingga mencapai 17% di Indonesia. Apabila kehilangan hasil padi rata-rata 6% akibat serangan tikus dapat ditiadakan maka volume beras yang diselamatkan dapat memenuhi kebutuhan 225 juta orang selama satu tahun. Di Asia Tenggara, tikus sawah (*Rattus argentiventer*) termasuk hama penting, terutama di Indonesia dan Vietnam.

BB Padi melalui kerja sama dengan ACIAR dan IRRI telah mengembangkan teknologi bubu perangkap (TBS) untuk mengendalikan tikus di sawah. Teknologi ini dinilai efektif dan tidak mengganggu tanaman padi dan lingkungan. TBS terdiri atas bubu perangkap, plastik penghalang, dan tanaman perangkap yang ditanam tiga minggu lebih awal untuk menarik tikus masuk ke TBS.

Pengendalian tikus dengan TBS akan lebih efektif jika dikombinasikan dengan tindakan berikut:

- Saluran irigasi dibuat dengan lebar kurang dari 30 cm sehingga sulit bagi tikus untuk membuat sarang.
- Melakukan kampanye kepada masyarakat tentang pengendalian tikus dengan cara konvensional 30 hari setelah tanam (sebelum tikus berkembang biak). Pengendalian diarahkan ke batas desa, saluran irigasi utama, dan pinggir jalan.
- Membersihkan gabah yang tercecer pada saat panen.
- Mensinkronisasikan penanaman padi paling lambat dua minggu.



Gambar 5. Penerapan TBS/LTBS di sawah irigasi di Kebun Inti, Puyung, Lombok Tengah, Nusa Tenggara Barat, Oktober 2010

Teknologi Pascapanen

Peneliti Badan Litbang Pertanian telah menguji dan memodifikasi prototipe alat-mesin pertanian rancangan IRRI, termasuk *hydro tillers*, *drum seeders*, dan *seeders* untuk padi gogorancah (benih kering) dan padi gogo. Di beberapa daerah, *drum seeder* atau alat tanam benih langsung (benih basah) telah diperkenalkan kepada petani. Beberapa petani yang mengadopsi teknologi ini memodifikasi *drum seeder*, sesuai dengan kebutuhan mereka.

Tingkat kehilangan dan kerusakan gabah selama penyimpanan cukup tinggi. Penyimpanan gabah dengan sistem kedap udara telah dimulai di Sumatera Selatan. Sistem ini efektif menekan perkembangan serangga selama penyimpanan dan mutu beras giling tetap terpelihara.

Bank Pengetahuan Padi Indonesia

Kerja sama IRRI dan Badan Litbang Pertanian untuk menyebarkan informasi teknologi perpadian diupayakan melalui Bank Pengetahuan Padi Indonesia (BPPI) yang dikelola oleh Pusat Perpustakaan dan Penyebaran Teknologi Pertanian (PUSTAKA).

Gambar 6. Versi *online* BBPI (*Indonesia Rice Knowledge Bank*) yang dapat diakses di http://www.pustaka-deptan.go.id

Gambar 7. BBPI versi CD ROM

Luas Tanam Varietas Padi Asal Galur IRRI

Banyak manfaat dari kerja sama Badan Litbang Pertanian dengan IRRI. Sebanyak 62 varietas padi yang dilepas Indonesia (Tabel 3) berasal dari galur yang dirakit oleh IRRI. Sebagian lagi varietas padi yang dilepas di Indonesia dirakit dengan menggunakan bahan genetik IRRI sebagai tetua. Sekitar 70-80% varietas padi yang ditanam petani di Indonesia berasal dari galur IRRI atau keturunan hasil persilangan galur-galur IRRI (Tabel 4).

Tabel 3. Varietas padi yang diintroduksi dari IRRI dalam periode 1967-2009

No.	Nama	Galur IRRI	Asal dilepas	Tahun	Ekosistem
1	PB-5	IR5-47-2	IRRI	1967	Sawah irigasi
2	PB-8	IR8-288-3	IRRI	1967	Sawah irigasi
3	PB-20	IR532-E-576-2	IRRI	1974	Sawah irigasi
4	PB-26	IR1541-10207	IRRI	1975	Sawah irigasi
5	PB-28	IR2061-214-3-8-2	IRRI	1975	Sawah irigasi
6	PB-30	IR2153-159-1-4	IRRI	1975	Sawah irigasi
7	PB-34	IR2061-213-2-17	IRRI	1976	Sawah irigasi
8	PB-32	IR2070-147-6-3-2	IRRI	1977	Sawah irigasi
9	Asahan	IR2071-621-2-3	IRRI	1978	Sawah irigasi
10	IR36	IR2071-625-1-252	IRRI	1978	Sawah irigasi
11	PB-38	IR2070-423-2-5-6	IRRI	1978	Sawah irigasi
12	IR42	IR2071-586-5-6-3-4	IRRI	1980	Sawah irigasi
13	Semeru	IR2307-247-2-2-3	IRRI	1980	Sawah irigasi
14	PB-50	IR9224-117-2-3-3-2	IRRI	1981	Sawah irigasi
15	PB-52	IR5853-778-5	IRRI	1981	Sawah irigasi
16	PB-54	IR5853-162-1-2-3	IRRI	1981	Sawah irigasi
17	Bahbolon	IR15529-253-2-2	IRRI	1983	Sawah irigasi
18	Citanduy	IR5657-33-2-2-3	IRRI	1983	Sawah irigasi
19	IR46	IR2058-78-1-3-2-3	IRRI	1983	Sawah irigasi
20	Kelara	IR13543-66	IRRI	1983	Sawah irigasi

Tabel 3. (Lanjutan)

No.	Nama	Galur IRRI	Asal dilepas	Tahun	Ekosistem
21	PB-56	IR13429-109-2-2-1	IRRI	1983	Sawah irigasi
22	Tajum	IR4744-128-2-3-4-ck-4	IRRI	1985	Sawah irigasi
23	IR48	IR4570-83-3-3-2	IRRI	1986	Sawah irigasi
24	IR64	IR18348-36-3-3	IRRI	1986	Sawah irigasi
25	IR65	IR21015-196-3-1-3	IRRI	1986	Beras ketan
26	Nagara = PAD 4	IR11141-6-1-4	IRRI	1986	Pasang surut
27	Alabio = PAD 6	SPR7232-2-3-1	IRRI	1986	Pasang surut
28	Tapus	IR11188-B-B-118-1	IRRI	1986	Pasang surut
29	Dodokan	IR28128-45-3-3-2	IRRI	1987	Sawah irigasi
30	Jangkok	IR19743-46-2-3-3-2	IRRI	1987	Sawah irigasi
31	Batang Sumani	IR26110f-Sr-4	IRRI	1989	Sawah irigasi
32	C22	C22-MR-9-7	Philippines	1989	Lahan kering
33	IR 66	IR32307-107-3-2-2	IRRI	1989	Sawah irigasi
34	IR 70	IR28228-12-3-1-1-2	IRRI	1989	Sawah irigasi
35	IR 72	IR35366-90-3-2-1-2 (IR72-Mr-1)	IRRI	1989	Sawah irigasi
36	IR 74	IR32453-20-3-2-2-M-1	IRRI	1991	Sawah irigasi
37	Barumun	IR19661-131-1-31-3	IRRI	1991	Sawah irigasi
38	Seililin	IR11288-B-B-69-4	IRRI	1991	Pasang surut
39	IR68	IR28224-3-2-3-2	IRRI	1993	Sawah irigasi
40	Gajah Mungkur	IRAT112	Ivory Coast	1994	Lahan kering
41	Kalimutu	IAC220/79	IRRI	1994	Lahan kering
42	Dendang	IR52952-B-B-3-3-2	IRRI	1999	Pasang surut
43	Bondoyudo	IR60819-34-2-1 (Hd174)	IRRI	2000	Sawah irigasi
44	Celebes	IR31892-100-3-3-3-3	IRRI	2000	Sawah irigasi
45	Kalimas	IR59552-21-3-2-2 (HD176)	IRRI	2000	Sawah irigasi
46	Tukad Balian	IR59682-132-1-1-1-2	IRRI	2000	Sawah irigasi
47	Tukad Petanu	IR 69726-116-1-3	IRRI	2000	Sawah irigasi
48	Tukad Unda	IR68305-8-1	IRRI	2000	Sawah irigasi
49	Silugonggo	IR39357-71-1-1-2-2	IRRI	2001	Sawah irigasi
50	Maro	H2	IRRI	2002	Hibrida
51	Rokan	H1	IRRI	2002	Hibrida
52	Batang Piaman	SPR85163-5-1-2-4	Thailand	2003	Sawah irigasi
53	HIPA 5 CEVA	IR58025A/BR168	IRRI	2007	Hibrida
54	Inpara-3	IR70213-9-CPA-12-UBN-2-1-3-1	IRRI	2008	Pasang surut
55	Inpari-5 Merawu	IR65600-21-2-2	IRRI	2008	Sawah irigasi
56	Inpago 6	IR30176-B-2-MR-1	IRRI	2009	Lahan kering
57	Inpara 4	IR05F101	IRRI	2009	Pasang surut dan toleran rendaman
58	Inpara 5	IR07F101	IRRI	2009	Pasang surut dan toleran rendaman
59	Inpari 8	IR73012-15-2-2-1	IRRI	2009	Sawah irigasi
60	Inpari 9 Elo	IR73005-69-1-1-2	IRRI	2009	Sawah irigasi
61	HIPA 7	IR58025A/IR40750	IRRI	2009	Hibrida
62	HIPA 11	IR68897A/IR40750	IRRI	2009	Hibrida

Tabel 4. Luas tanam galur IRRI yang telah dilepas sebagai varietas padi atau galur IRRI sebagai tetua persilangan varietas padi Indonesia

Luas tanam (ha)	Galur IRRI yang dilepas di Indonesia		Galur IRRI sebagai salah satu tetua	
	Varietas	Luas tanam (ha)	Varietas	Luas tanam (ha)
Musim Kemarau (MK) 1980				
51.000-100.000			Pelita I-1	76.617
101.000-150.000				
150.000-200.000				
201.000-250.000	IR32	248.281		
>251.000	IR38	293.343		
	IR36	1.128.297		
MK 1990				
51.000-100.000	Semeru	60.399	Cisokan	64.628
	IR48	69.823		
101.000-150.000	IR46	105.222	Krueng Aceh	121.395
150.000-200.000	IR42	178.653	Ciliwung	154.988
201.000-250.000	IR32	229.889		
>251.000	IR64	1.183.597	Cisadane	452.041
MK 2000				
51.000-100.000	IR74	54.451	Digul	55.969
			Cisokan	75.307
			Cisadane	92.550
101.000-150.000	IR66	114.849		
150.000-200.000	IR42	183.544	Memberamo	153.594
201.000-250.000			Way Apo Buru	224.259
			Ciliwung	228.477
>251.000	IR64	1.335.723		
MK 2009				
51.000-100.000			Cibogo	76.626
			Cilamaya Muncul	86.775
			Pepe	97.819
101.000-150.000			Ciliwung	104.192
150.000-200.000	IR42	150.691	Mekongga	157.357
201.000-250.000				
>251.000	IR64	675.524	Cigeulis	332.935
			Ciherang	2.130.743

Sumber: Direktorat Benih, Ditjen Tanaman Pangan

Mega proyek memprakarsai kerja sama penelitian internasional *Reversing Trends of Declining Rice Productivity*. Melalui mega proyek ini, BB Padi mengembangkan pendekatan PTT padi. Kementerian Pertanian melalui Direktorat Jenderal Tanaman Pangan melaksanakan program Sekolah Lapangan untuk mempromosikan PTT dalam program Peningkatan Produksi Beras Nasional, yang populer disingkat P2BN.

Ketersediaan air dalam jumlah yang tidak memadai merupakan faktor pembatas produksi padi di lahan sawah tadah hujan. Pengembangan sistem gogorancah pada agroekosistem ini adalah untuk menghindari dampak kekurangan air bagi tanaman selama fase reproduktif. Melalui konsorsium penelitian padi sawah tadah hujan (*Rainfed Lownland Rice Research Consortium* = RLRRC), sistem gogorancah dapat diintesifkan melalui penerapan PTT. Teknologi sebagai bagian penting dari komponen PTT dirakit melalui penelitian adaptasi varietas padi, dinamika pemupukan, dan teknik budi daya. Prospek penelitian ini dievaluasi dari segi sosio-ekonomi. Hasil penelitian menunjukkan bahwa intensitas tanam dan pola tanam di lahan sawah tadah hujan dapat ditingkatkan dan diperbaiki jika air tersedia. Pengembangan embung (waduk kecil) pada agroekosistem ini bertujuan untuk menangkap kelebihan pasokan air selama musim hujan dan berperan penting untuk mengantisipasi kekeringan pada musim kemarau.

Perakitan varietas padi tipe baru yang berdaya hasil tinggi oleh IRRI menggunakan padi bulu, plasma nutfah asal Indonesia (javanica). Galur IR65600, IR66160, dan IR66738 digunakan dalam persilangan di BB Padi sejak 1995. Varietas Fatmawati merupakan padi tipe baru yang dilepas untuk pertama kalinya, meskipun masih perlu perbaikan untuk mengurangi jumlah gabah hampa, mempermudah perontokan gabah, dan ketahanan terhadap HDB.

Penelitian gas rumah kaca di Jakenan Jawa Tengah mengukur volume emisi CH_4 dari lahan sawah irigasi dan sawah tadah hujan. Mitigasi emisi CH_4 dan adaptasi teknologi bertujuan untuk mengantisipasi perubahan iklim. Penelitian ini dan konsorsium RLRCC telah mengangkat status Kebun Percobaan Jakenan menjadi Balai Penelitian Lingkungan Pertanian yang menjadi acuan dalam mengantisipasi dampak perubahan iklim terhadap keberlanjutan sistem produksi pertanian.

Pelatihan

Dalam periode 1965-2009, IRRI telah memberikan beasiswa bagi 193 peneliti Indonesia. Sebanyak 40 peneliti Indonesia yang mendapat beasiswa dari IRRI telah mendapat gelar sarjana, 32 master, dan 117 doktor. Dua orang lainnya mendapat kesempatan untuk *on-the-job trainee*.

Hingga tahun 2008, sebanyak 798 peneliti Indonesia telah berpartisipasi dalam pelatihan jangka pendek di IRRI.

Kontribusi Finansial Pemerintah Indonesia

Pemerintah Indonesia, menggunakan dana pinjaman Bank Dunia, memberikan kontribusi sebesar US $ 1.820.187 selama periode 1973-1981. Anggaran ini diperuntukkan bagi pengembangan fasilitas penelitian di Balai Penelitian Tanaman Pangan Cabang Sukamandi (kini BB Padi) dan kegiatan penelitian padi di lapangan. Pemerintah Indonesia juga telah memberikan kontribusi sebesar US $ 124.000 untuk Agenda Penelitian IRRI periode 1993-1999.

Pada akhir tahun 2010, Pemerintah Indonesia menyetujui kontribusi anggaran secara formal untuk IRRI guna membantu meningkatkan produksi beras di Indonesia dengan memanfaatkan teknologi yang telah dihasilkan.

Dewan Pembina IRRI

Dewan Pembina IRRI terdiri atas para ahli dari berbagai negara yang berperan penting dalam mengarahkan strategi IRRI. Sejak 1970-an, delapan ahli dari Indonesia telah menerima kehormatan untuk menjadi anggota dewan IRRI (*Board of Trustees*).

Pada tahun 2000-an, Prof. Dr. Sjarifuddin Baharsjah adalah orang Indonesia pertama yang terpilih sebagai Ketua Dewan Pembina IRRI. Delapan pakar Indonesia lainnya yang terpilih sebagai anggota dewan IRRI adalah:

- Prof. Dr. Tojib Hadiwidjaja 1970 - 1973
- Prof. Dr. Gunawan Satari 1974 - 1977
- Mr. Sadikin Sumintawikarta 1978 - 1983
- Prof. Dr. Ida Nyoma Oka 1984 - 1989
- Prof. Dr. Ibrahim Manwan 1990 - 1995
- Prof. Dr. Sjarifuddin Baharsjah 1996 - 2001
- Dr. Achmad M. Fagi 2002 - 2007
- Prof. Dr. Achmad Suryana 2008 - Sekarang

Menteri Pertanian, Dr. Suswono, dalam peringatan Hari Pangan se-Dunia ke-30 di Lombok Tengah, NTB, 19-22 Oktober 2010, menekankan pentingnya kemandirian pangan untuk memerangi kelaparan

Menteri Pertanian, Dr. Suswono (kiri), melakukan panen perdana padi varietas Inpari 13 di petak demonstrasi varietas unggul baru tanaman pangan di Lombok Tengah, NTB, 19 Oktober 2010

Kepala Badan Litbang Pertanian, Dr. Haryono, menjelaskan peranan penelitian dalam menghasilkan inovasi teknologi padi kepada Komisi IV DPR RI pada 18 Desember 2010 di Sukamandi, Jawa Barat

Presiden RI, Susilo Bambang Yudhoyono, pada pembukaan Pekan Padi Nasional III di BB Padi, Sukamandi, 21 Juli 2008, mendapat penjelasan dari Dr. Hasil Sembiring tentang varietas unggul baru padi yang telah dan akan dikembangkan ke petani

Kepala Puslitbang Tanaman Pangan, Dr. Hasil Sembiring, menerima kunjungan Komisi IV DPR RI di BB Padi, Sukamandi 18 Desember 2010

Pengembangan Teknologi Padi

Pada tahun 2010, seperti pada tahun sebelumnya, perwakilan IRRI di Indonesia menerima dana dari Pemerintah Indonesia melalui Puslitbang Tanaman Pangan yang dialokasikan untuk memproduksi dan berperan serta mendistribusikan materi diseminasi hasil kerja sama penelitian. Materi diseminasi tersebut antara lain berupa poster, leaflet, DVD, buklet, dan buku saku.

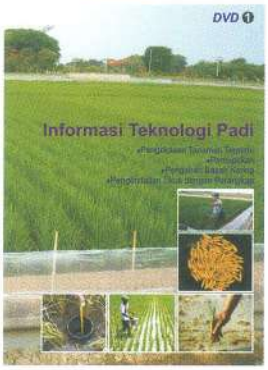
Bahan diseminasi teknologi padi IRRI yang sudah dipublikasikan:

Poster Padi Toleran Rendaman

Poster ini berisi informasi ringkas tentang padi toleran rendaman, varietas yang sudah dilepas, dsb, dicetak pada tahun 2010.

Poster Pengairan Basah Kering, berisi informasi ringkas mengenai teknologi hemat air

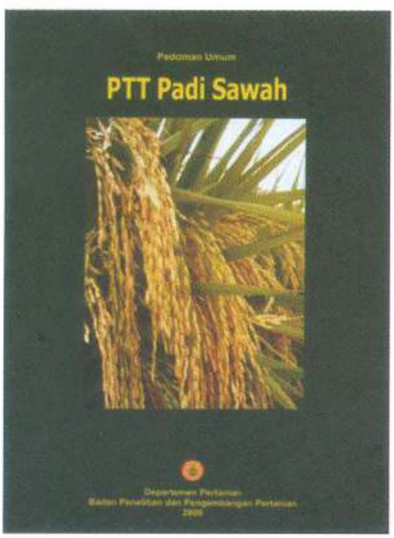
DVD Informasi Teknologi Padi, berisi video tentang PTT, pemupukan pada padi sawah, PBK, dan TBS



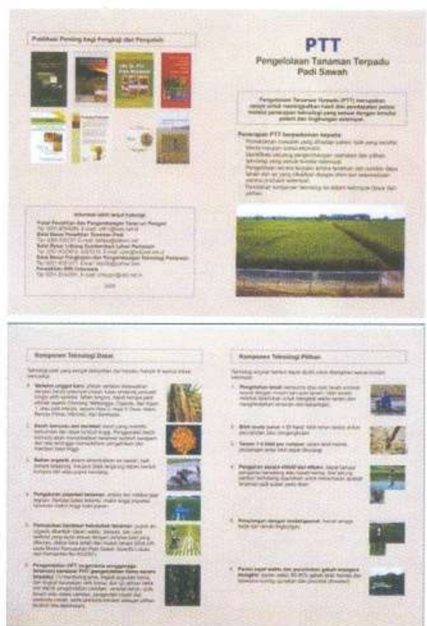
Leaflet pengendalian wereng batang coklat

Berisi informasi ringkas mengenai hama wereng batang coklat, kerdil rumput, kerdil hampa, dan cara pengendaliannya.

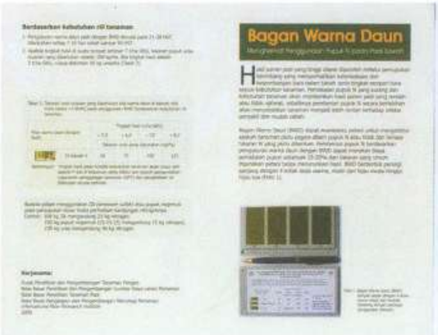
Pedoman Umum PTT Padi Sawah



Leaflet PTT Padi Sawah

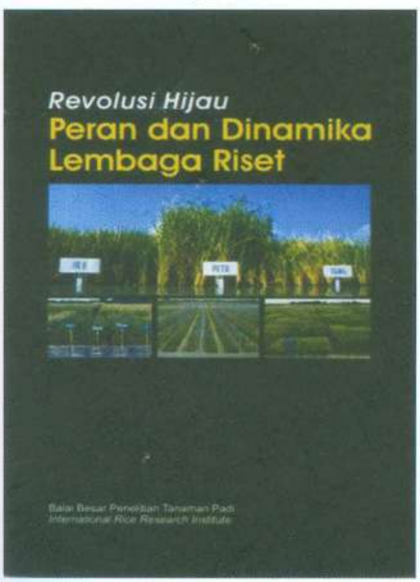


Leaflet Bagan Warna Daun

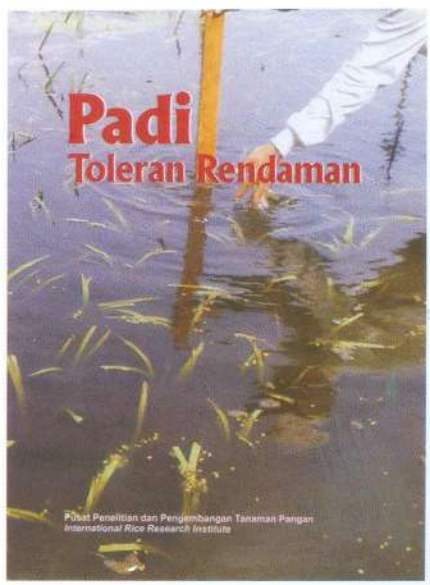


Leaflet Karung Super

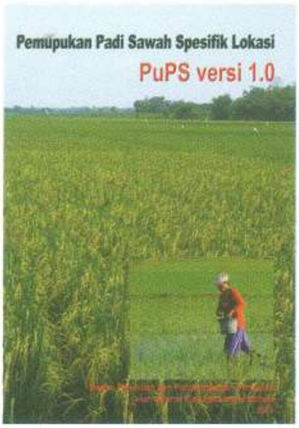
Buklet Revolusi Hijau: Peran dan Dinamika Lembaga Riset



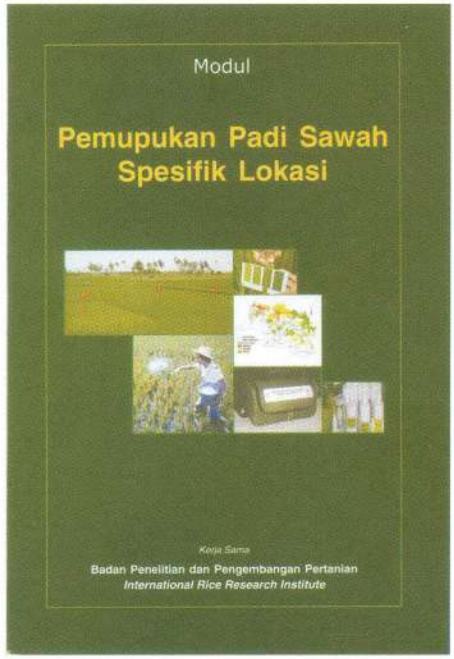
Buklet Padi Toleran Rendaman



Piranti lunak PuPS



Modul PHSL Padi Sawah



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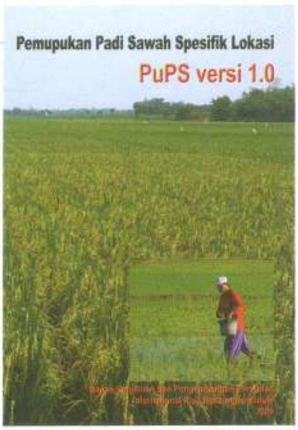
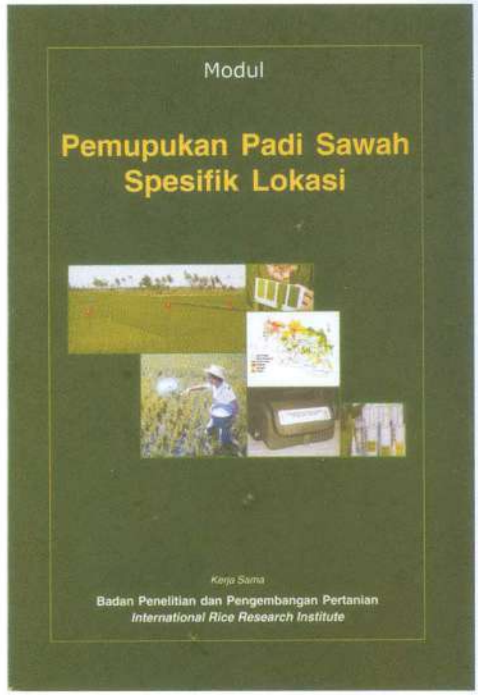
Nutrient Manager for rice



SSNM modul for lowland rice



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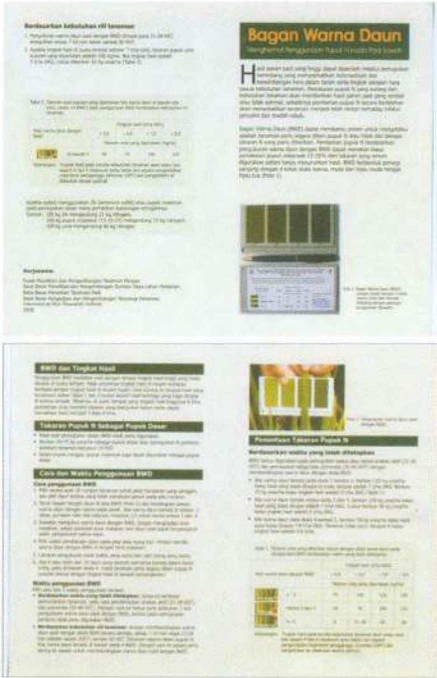
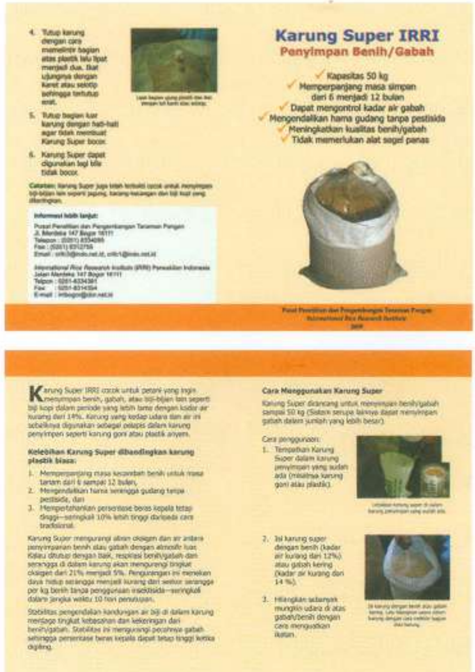
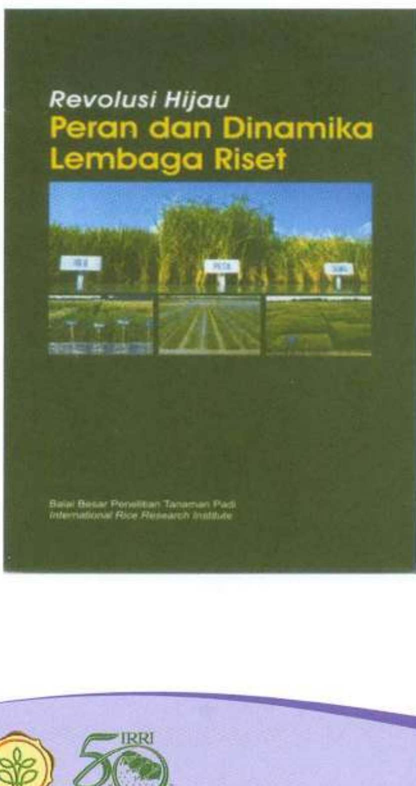
Leaflet of LCC



Leaflet of IRRI super bag

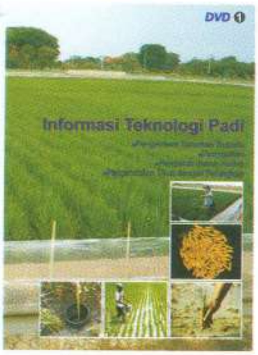


Booklet of green revolution and role of Indonesian research center

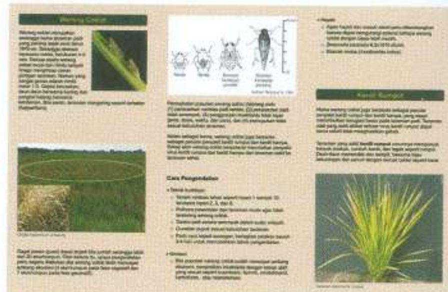


Booklet of submergence rice tolerant

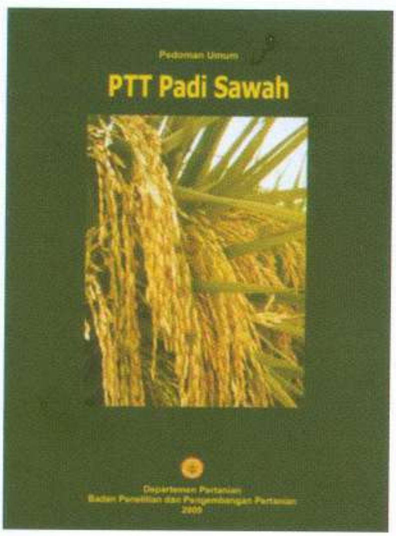
DVD information of rice technology
consisted of ICM, SSNM, AWD, and TBS video



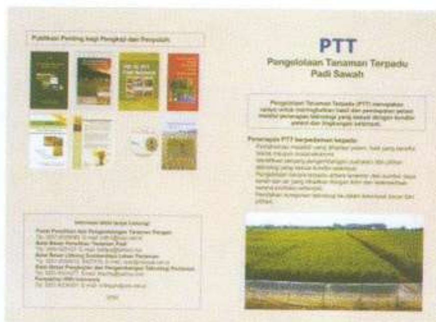
Leaflet of BPH
This leaflet contains brief information on BPH, rice grassy stunt, rice ragged stunt virus and their control



Booklet of integrated crop management for rice



Leaflet of ICM



Dissemination tool of rice technology

In 2010, as in the previous year, IRRI representative in Indonesia receive substantial fund from the GOI through ICFORD allocated to produce and distribute dissemination materrials.

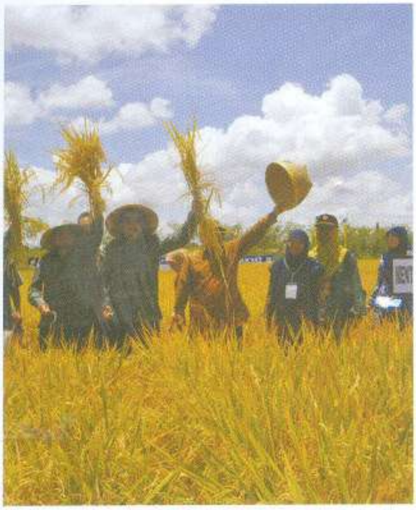
Material dissemination of IRRI rice technology are:

Submergence Rice Tolerant

This foster contain brief information on rice tolerant to submergence.

Alternate Wetting and Drying

A practical way to implement AWD is to monitor the depth of the water table in the field using a perforated or punctured water tube.



Ministry of Agriculture, Dr. Suswono (far left), performed the first harvest of rice varieties Inpari 13 in demonstration plots of new high yielding rice varieties in Central Lombok, West Nusa Tenggara, October 19, 2010

Director General of Indonesia Agency for Agricultural Research and Development, Dr. Haryono, explained the role of rice research in producing technological innovations to the House of Representatives Commission IV on December 18, 2010 in Sukamandi, West Java

President of the Republic of Indonesia, Susilo Bambang Yudhoyono received explanation from Dr. Hasil Sembiring of new high yielding rice varieties that have been developed and will be introduced to the farmers, during the 3[th] National Rice Week at Indonesia Center for Rice Research, on 21 July 2008

The Director of Indonesia Center for Food Crops Research and Development, Dr. Hasil Sembiring, received members of the House of Representative Commission IV during a visit to Indonesia Center for Rice Research, on December 18, 2010

Board of Trustees (BOT)

The IRRI Board of Trustees comprises of prominent experts from various countries who play an important role in directing strategy to be taken by IRRI's top management. Since the 1970s, eight Indonesian experts have received the honor to be members of the board.

In late 2000, Prof Dr. Sjarifuddin Baharsjah was the first Indonesia to be elected as the chairman of the board. The eight Indonesia experts elected as board members are:

- Prof. Dr. Tojib Hadiwidjaja 1970 - 1973
- Prof. Dr. Gunawan Satari 1974 - 1977
- Mr. Sadikin Sumintawikarta 1978 - 1983
- Prof. Dr. Ida Nyoma Oka 1984 - 1989
- Prof. Dr. Ibrahim Manwan 1990 - 1995
- Prof. Dr. Sjarifuddin Baharsjah 1996 - 2001
- Dr. Achmad M. Fagi 2002 - 2007
- Prof. Dr. Achmad Suryana 2008 - now

Significant events in ICRR - IRRI History

Ministry of Agriculture, Dr. Suswono, in celebration of the 30th World Food Day in Central Lombok, West Nusa Tenggara, emphasized the importance of food-self sufficiency to combat hunger

Research on greenhouse gas emissions measures the amount of methane (CH_4) emissions from irrigated and rainfed lowland area. Research to develop technology for mitigation and adaptation was conducted to produce guidance in anticipation of climate change. Through this research and research under RLRRC, the Jakenan Experimental Station had been promoted to become Indonesia for Agriculture Environment Research Institute, a reference institute in anticipating climate changes.

Training

There were a total of 193 IRRI scholars from Indonesia from 1965-2009, 32 of them were female and 161 were male. About 40 Indonesia scholars received a Bachelor's degree, 32 got a Master's degree, 117 became PhD scholars, 2 became on-the-job (OJT) trainees, 193 became a Fellow and another two became Interns.

A total of 798 Indonesian participated in IRRI's short-term course, 136 of them were female and 662 were male.

Financial contributions from Indonesia

The Government of Indonesia, using a World Bank loan, contributed to IRRI an amount of US$ 1,820,187 during a period 1973 to 1981. This was for the development of research facilities at Sukamandi Branch of the Central Research Institute for Food Crops and for scientific and technical assistance to rice research at Sukamandi, now named as ICRR. The Government of Indonesia contributed a total of US$124,000 to IRRI's Research Agenda from 1993 to 1999.

At the end of 2010, Ministry of Agriculture proposed to President of the Republic of Indonesia a formal financial contribution to IRRI to help increasing Indonesia's rice production by taking advantages of IRRI generated technologies.

Mega Project initiated an international collaborative research with a title Reversing Trends of Declining Rice Productivity which was conducted from 1993 to 2000. The project generated information on agronomic research based knowledge to develop cultivation and fertilizer application recommendation. One of the achievements of this project is a development of SSNM approach..

Research by Indonesia Rice Research Institute, now known as Indonesia Center for Rice Research, ICRR, has generated series of technology information that later it was reviewed and developed as an Integrated Crop Management concept. The Ministry of Agriculture through the Directorate General for Food Crops is implementing the ICM Field School to promote the increase of the national rice production.

Water availability is a limiting factor of rainfed lowland rice (*Gogorancah* system). Gogorancah system is well known in Indonesia and it was developed to avoid water shortages during the rice reproductive phase. Through Rainfed Lowland Rice Research Consortium (RLRRC), this system is intensified through the application of ICM concept. The technology as part of the ICM components assembled from adaptation studies of rice varieties, dynamics of fertilization, and cultivation techniques. Cropping intensity and cropping pattern in rainfed lowland can be improved and repaired, if water is available. The design and prospects of *embung* (small farm reservoir) to capture excess water supply during wet season have proven to be usefull. The local administration in Central Java has adopted this system and developed hundreds of *embung* of different sizes.

The assembly of hybrid rice is a long process. Two hybrids rice from IRRI were released as Maro and Rokan varieties in 2002. Hybrid rice Hipa 3, Hipa 4, Hipa 5 Ceva, and Hipa 6 Jete were released in 2004-2006. Hybrid rice still needs to be improved with addition of resistant trait to brown plant hopper pest, and tungro and BLB diseases.

The assembly of a new plant type (VUTB) of high yielding varieties by IRRI, employed bulu (Javanica) rice gene pool of rice germplasm from Indonesia. Lines IR65600, IR66160 and IR66738 have been used in cross breeding by Indonesia Rice Research Institute since 1995. Fatmawati, the new plant type of rice variety have been released but still needs to be improved to reduce number of unfilled grain, increased easeness of threshing grain, and resistant to BLB.

Table 4. Area planted by IRRI lines as Indonesian rice variety or IRRI line crossing as parental of Indonesian rice variety

Area planted (ha)	IRRI lines released as Indonesian rice variety		IRRI line crossed as parental of Indonesian as rice variety	
	Variety	Area planted (ha)	Variety	Area planted (ha)
Dry Season 1980				
51,000-100,000			Pelita I-1	76.617
101,000-150,000				
150,000-200,000				
201,000-250,000	IR32	248.281		
>251,000	IR38	293.343		
	IR36	1.128.297		
Dry Season 1990				
51,000-100,000	Semeru	60.399		
	IR48	69.823	Cisokan	64.628
101,000-150,000	IR46	105.222	Krueng Aceh	121.395
150,000-200,000	IR42	178.653	Ciliwung	154.988
201,000-250,000	IR32	229.889		
>251,000	IR64	1.183.597	Cisadane	452.041
Dry Season 2000				
51,000-100,000	IR74	54.451	Digul	55.969
			Cisokan	75.307
			Cisadane	92.550
101,000-150,000	IR66	114.849		
150,000-200,000	IR42	183.544	Memberamo	153.594
201,000-250,000			Way Apo Buru	224.259
			Ciliwung	228,477
>251,000	IR64	1.335.723		
Dry Season 2009				
51,000-100,000			Cibogo	76.626
			Cilamaya Muncul	86.775
			Pepe	97.819
101,000-150,000			Ciliwung	104.192
150,000-200,000	IR42	150.691	Mekongga	157.357
201,000-250,000				
>251,000	IR64	675.524	Cigeulis	332.935
			Ciherang	2,130.743

Source: Directorate of Seeds, Directorate General for Food Crops

Table 3. Continued

No.	Name	IRRI lines	Origin	Year release	Ecosystem
21	PB-56	IR13429-109-2-2-1	IRRI	1983	Irrigated lowland
22	Tajum	IR4744-128-2-3-4-ck-4	IRRI	1985	Irrigated lowland
23	IR48	IR4570-83-3-3-2	IRRI	1986	Irrigated lowland
24	IR64	IR18348-36-3-3	IRRI	1986	Irrigated lowland
25	IR65	IR21015-196-3-1-3	IRRI	1986	Sticky rice
26	Nagara = PAD 4	IR11141-6-1-4	IRRI	1986	Tidal swamp
27	Alabio = PAD 6	SPR7232-2-3-1	IRRI	1986	Tidal swamp
28	Tapus	IR11188-B-B-118-1	IRRI	1986	Tidal swamp
29	Dodokan	IR28128-45-3-3-2	IRRI	1987	Irrigated lowland
30	Jangkok	IR19743-46-2-3-3-2	IRRI	1987	Irrigated lowland
31	Batang Sumani	IR26110f-Sr-4	IRRI	1989	Irrigated lowland
32	C22	C22-MR-9-7	Philippines	1989	Upland
33	IR 66	IR32307-107-3-2-2	IRRI	1989	Irrigated lowland
34	IR 70	IR28228-12-3-1-1-2	IRRI	1989	Irrigated lowland
35	IR 72	IR35366-90-3-2-1-2	IRRI	1989	Irrigated lowland
36	IR 74	IR32453-20-3-2-2-M-1	IRRI	1991	Irrigated lowland
37	Barumun	IR19661-131-1-31-3	IRRI	1991	Irrigated lowland
38	Seililin	IR11288-B-B-69-4	IRRI	1991	Tidal swamp
39	IR68	IR28224-3-2-3-2	IRRI	1993	Irrigated lowland
40	Gajah Mungkur	IRAT112	Ivory Coast	1994	Upland
41	Kalimutu	IAC220/79	IRRI	1994	Upland
42	Dendang	IR52952-B-B-3-3-2	IRRI	1999	Tidal swamp
43	Bondoyudo	IR60819-34-2-1 (HD174)	IRRI	2000	Irrigated lowland
44	Celebes	IR31892-100-3-3-3-3	IRRI	2000	Irrigated lowland
45	Kalimas	IR59552-21-3-2-2 (HD176)	IRRI	2000	Irrigated lowland
46	Tukad Balian	IR59682-132-1-1-1-2	IRRI	2000	Irrigated lowland
47	Tukad Petanu	IR 69726-116-1-3	IRRI	2000	Irrigated lowland
48	Tukad Unda	IR68305-8-1	IRRI	2000	Irrigated lowland
49	Silugonggo	IR39357-71-1-1-2-2	IRRI	2001	Irrigated lowland
50	Maro	H2	IRRI	2002	Hybrid rice
51	Rokan	H1	IRRI	2002	Hybrid rice
52	Batang Piaman	SPR85163-5-1-2-4	Thailand	2003	Irrigated lowland
53	HIPA 5 CEVA	IR58025A/BR168	IRRI	2007	Hybrid rice
54	Inpara-3	IR70213-9-CPA-12-UBN-2-1-3-1	IRRI	2008	Tidal swamp
55	Inpari-5, Merawu	IR65600-21-2-2	IRRI	2008	Irrigated lowland
56	Inpago 6	IR30176-B-2-MR-1	IRRI	2009	Upland
57	Inpara 4	IR05F101	IRRI	2009	Tidal swamp
58	Inpara 5	IR07F101	IRRI	2009	Tidal swamp
59	Inpari 8	IR73012-15-2-2-1	IRRI	2009	Irrigated lowland
60	Inpari 9 Elo	IR73005-69-1-1-2	IRRI	2009	Irrigated lowland
61	HIPA 7	IR58025A/IR40750	IRRI	2009	Hybrid rice
62	HIPA 11	IR68897A/IR40750	IRRI	2009	Hybrid rice

Area planted with rice varieties of IRRI origin lines

Many Indonesian rice varieties released since 1967 originated from pure IRRI lines and the rest of rice varieties developed by Indonesian rice breeders used IRRI genetic material as parental line (Table 3). Troughout the years, farmers continuosly planted their rice field with varieties developed by rice breeders in collaboration with IRRI scientists. About 80% of rice varieties planted by farmers in Indonesia are IRRI or IRRI-derived lines (Table 4).

Table 3. Indonesia rice variety introduced from IRRI from 1967-2009

No.	Name	IRRI lines	Origin	Year release	Ecosystem
1	PB-5	IR5-47-2	IRRI	1967	Irrigated lowland
2	PB-8	IR8-288-3	IRRI	1967	Irrigated lowland
3	PB-20	IR532-E-576-2	IRRI	1974	Irrigated lowland
4	PB-26	IR1541-10207	IRRI	1975	Irrigated lowland
5	PB-28	IR2061-214-3-8-2	IRRI	1975	Irrigated lowland
6	PB-30	IR2153-159-1-4	IRRI	1975	Irrigated lowland
7	PB-34	IR2061-213-2-17	IRRI	1976	Irrigated lowland
8	PB-32	IR2070-147-6-3-2	IRRI	1977	Irrigated lowland
9	Asahan	IR2071-621-2-3	IRRI	1978	Irrigated lowland
10	Ir36	IR2071-625-1-252	IRRI	1978	Irrigated lowland
11	PB-38	IR2070-423-2-5-6	IRRI	1978	Irrigated lowland
12	IR42	IR2071-586-5-6-3-4	IRRI	1980	Irrigated lowland
13	Semeru	IR2307-247-2-2-3	IRRI	1980	Irrigated lowland
14	PB-50	IR9224-117-2-3-3-2	IRRI	1981	Irrigated lowland
15	PB-52	IR5853-778-5	IRRI	1981	Irrigated lowland
16	PB-54	IR5853-162-1-2-3	IRRI	1981	Irrigated lowland
17	Bahbolon	IR15529-253-2-2	IRRI	1983	Irrigated lowland
18	Citanduy	IR5657-33-2-2-3	IRRI	1983	Irrigated lowland
19	IR46	IR2058-78-1-3-2-3	IRRI	1983	Irrigated lowland
20	Kelara	IR13543-66	IRRI	1983	Irrigated lowland

Post harvest technology

IAARD scientists have tested and modified farm machinery prototypes created by IRRI. These include hydro tillers, drum seeders, and seeders for gogorancah (dry-seeded) and dryland farming. In some area, the drum seeder was introduced to farmers alongside direct (wet) seeding. Some farmers who adopted the technology modified the drum seeder to fit their needs.

As storage losses is quite significant in relation to the quality and quantity of rice post harvest, a study on hermetic sealed storage system was initiated in South Sumatra. With this system, the insect activity is reduced significantly while milling quality is maintained.

Rice Knowledge Bank

Collaboration between IRRI and IAARD to disseminate information of new rice technology is facilitated through the Indonesian Rice Knowledge Bank (*Bank Pengetahuan Padi Indonesia*/BPPI) which is managed by Indonesian Center of Agricultural Library and Technology Dissemination.

Figure 6. Online version of BBPI (**Indonesia Rice Knowledge Bank**) can be downloaded in http://www.pustaka-deptan.go.id

Figure 7. CD ROM version of BBPI (**Indonesia Rice Knowledge Bank**)

Rodent

Infestation of rodents have two major impacts. The first is the substantial pre- and postharvest losses they cause to agriculture. The second is as carriers of debilitating human diseases.

Across Asia, preharvest losses of rice range from 5% in Malaysia to 17% in Indonesia. To put this into perspective, a loss of 6% in Asia amounts to enough rice to feed 225 million people – roughly the population of Indonesia for 12 months. In Southeast Asia, the rice field rat (*Rattus argentiventer*) is the number-one preharvest pest in Indonesia and is one of the top three pests in Vietnam.

Through collaboration with ACIAR, a technology called trap barrier system (TBS) was developed to control rat in rice field. The technology is considered to be effective, does not perturb the rice crop, and environmentally safe. TBS consist of live traps, plastic barrier, and trap crop which was planted 3 weeks earlier or later to attract rats entering the TBS.

TBS is most effective when combined with the following community actions:

- Keep irrigation banks less than 30 cm wide to make it difficult for rats to build nests.
- Conduct community campaigns using local methods to control rats within 30 days of planting the crop (before rats breed); these community actions should focus on village guards, main irrigation channels, and roadsides.
- Clean up any grain spills at harvest.
- Synchronize planting so that crops are planted within 2 weeks of each other.

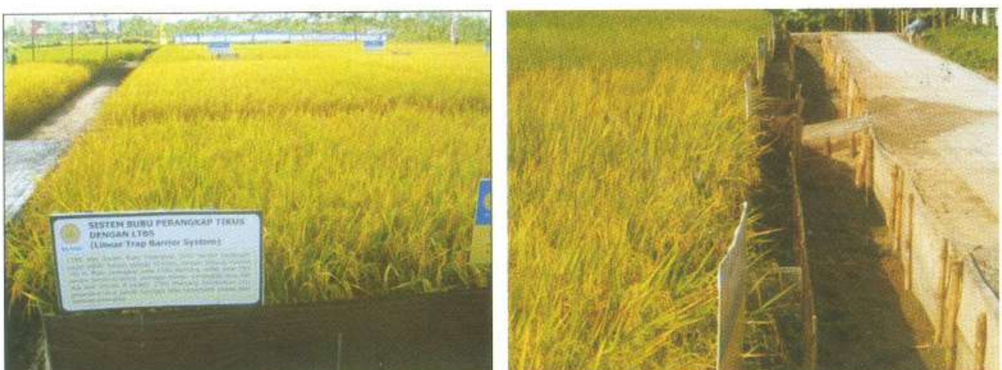


Figure 5. Application of TBS/LTBS in irrigated rice system, at Kebun Inti, Puyung, Central Lombok, West Nusa Tenggara Barat

allowed to dry for 2-4 days before getting re-flooded. Compared with the traditional continuous flooding system, AWD using lowland rice cultivars can reduce water input by 15-30% without yield loss. With drought-tolerant lowland rice cultivars, a longer interval of drying in a cycle and thus more saved water can be expected. In alternate wetting and drying (AWD), the field is allowed to dry for a certain number of days before applying irrigation water.

A practical way to implement AWD is to monitor the depth of water table in the field using a perforated or punctured water tube. After the field is irrigated, the field water depth will gradually decrease in time. When the water level (as measured in the tube) is 15 centimeters below the surface of the soil, it is time to irrigate and flood the soil with a depth of around 5 centimeters. Around flowering stage, from 1 week before to 1 week after the peak of flowering, pounded water should be kept at a 5-centimeter depth to avoid any water stress that would result in potentially severe yield loss.

The threshold of 15 centimeters is called safe AWD, because this will not cause yield decline since the roots of the rice plants will take up water from the saturated soil and the perched water in the roots. The field water tube helps farmers see this "hidden" source of water.

Figure 4. Left is a PVC pipe, center is the practice how to embed water pipe into the soil, and right is how to measure water depth using water pipe

Indonesia has a long and successful experience in assembling and disseminating rice-technology packages with technical components and economic consideration. Based on that experience, there is an opportunity to assist farmer groups to combine the best experiance of the existing rice-production with that of the twelve best management practices of ICM approach to raise rice productivity and production. The technologies are recommended based on an ecozone-specific integrated-rice-crop-management (ICM).

During 2008 to 2010, diffusion of ICM-Field-School expanded to two million hectares of irrigated lowland rice. Each unit of ICM-FFS comprises of 24 ha of farmers' fields and a one-hectare of farmer-managed Field Laboratory.

Site-specific nutrient management

Indonesian Government committed to reduce fertilizer subsidies to farmers. In consequence, fertilizers prices increased by 25% to 40 %. The price increase, together with the fore-mentioned increased in population and in rice demand, require that farmers must use fertilizers more efficiently. An IRRI-assisted Nutrient Manager help farmers to meet this requirement.

Nutrient Manager for rice is a decision support system to guide farmers and extensions in deciding the kind of fertilizer use, fertilizer rate, and time of fertilizer application. The Nutrient Manager is packaged on CD as PuPS-Version 1.0. This extension-oriented package is designed for high-yielding rice varieties in individual rice-growing areas, and requires integrated training of researcher, extension, and farmers. This software is supported by monitoring tools such as LCCs and soil-test facilities.

Alternate wetting and drying

Alternate wetting and drying (AWD) is a type of water-saving rice production system. In this system, the field is irrigated with enough water to flood the paddy for 3-5 days, and, as the water soaks into the soil, the surface is then

Figure 3. Rice crop of Inpari 13 at exhibition during the 30th World Food Day located in Kebun Inti, Puyung, Lombok Tengah, West Nusa Tenggara, October 2010

Drought-tolerant rice. Drought often threatens rice crops in rainfed fields, particularly the second, or dry-season, crop. Farmers have therefore relied on *gogorancah* or dry-seeded rice, followed by *walik jerami*, or zero-tillage rice, for the second crop. This practice allows early planting of the second crop, with the hope of thereby escaping drought during the dry season. One line has been released in year of 2009 and named it as Inpari 13.

Submergence tolerance rice. It was reported that every year more than 300,000 ha of rice fields suffered from flood. By growing a submergence tolerance variety such as Inpara 3 (IR70213-9CPA-12-UBN-2-1-3-1) released in 2008, Inpara 4 (Swarna-Sub1) and Inpara 5 (IR64-Sub1) released in 2009, the damage can be minimized since these varieties could withstand submergence condition up to 14 days.

Table 2. Hybrid rice varieties release in Indonesia

No	Release Name	Female parent	Origin	Male parent	Origin	Release Year
1.	Maro	IR58025A	IRRI	IR53942	IRRI	2002
2.	Rokan	IR58025A	IRRI	BR827	Bangladesh	2002
3.	HIPA3	IR58025A	IRRI	MTU9992	Introduces	2004
4.	HIPA4	IR58025A	IRRI	MTU9992	Introduces	2004
5.	HIPA5 CEVA	IR58025A	IRRI	BR168	Bangladesh	2007
6.	HIPA6 JETE	IR58025A	IRRI	B8049F	ICRR	2007
7.	HIPA7	IR58025A	IRRI	IR40750	IRRI	2009
8.	HIPA8 PIONER	IR58025A	IRRI	BP51	ICRR	2009
9.	HIPA9	IR58025A	IRRI	S4325D	ICRR	2009
10.	HIPA10	IR68897A	IRRI	BIO-9	ICRR	2009
11.	HIPA11	IR68897A	IRRI	IR40750	IRRI	2009

Anticipating the climate change

The current climate change has resulted in a warmer, dryer, yet wetter condition. Several characteristics of rice varieties are needed to face the change, i.e. tolerance to drought and submergence stresses as well as to heat. In addition, competition in water used by households and industries has also led to the need of efficient use of water for crop cultivation.

Rice molecular breeding strategy for developing Green Super Rice (GSR) cultivars. What is "GSR"?. Rice cultivars that produce higher and more stable yields with lesser inputs (water, fertilizers and pesticides). High yielding GSR cultivars with "Green" traits resistant or tolerant to:

- Abiotic stresses: drought, salinity, alkalinity, etc.
- Diseases: blast, bacterial blight, sheath blight, viruses, etc
- Insects: brown plant hopper, stem borer, etc
- High resource-use efficiency: water and nutrients (N, P)

Molecular assisted breeding and taft screening methods were applied in the development of GSR variety.

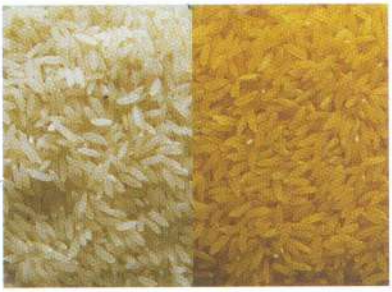


Figure 2. Ordinary rice (left), and *Golden Rice* (right)

Varieties with vitamin A, iron, and zinc. As many people in Asia, including Indonesia, suffered by insufficient vitamin A, iron (Fe), and zinc (Zn) in collaboration with IRRI, research has been directed to integrating such element in rice variety to enable the people to having such elements.

Lack of vitamin A can cause blindness. However, providing vitamin A orally for human food is problematic because of the lack of supporting infrastructure. So an alternative is needed to distribute consumption of vitamin A, especially for children. A breakthrough that could be done is to engineer rice to produce beta-carotene (provitamin A) in the seed (endosperm). Rice is selected because it is a staple food for people in many countries.

Under this collaborative research project, IRRI will assist ICRR to develop a Golden Rice variety for Indonesia by initiating a backcross of the lead Golden Rice 2 (GR2-R) to most of important rice varieties in Indonesia. After completing a Material Transfer Agreement, IRRI will transfer to ICRR the advance lines of these backcrossed materials. IRRI will fund the construction of transgenic screen house and the renovation and refurbishment of transgenic laboratory in the ICRR Muara Experimental Station in Bogor.

Hybrid rice. Hybrid rice has contributed significantly to China's food security for the past quarter of century, inspiring other countries to adopt and develop the technology. IRRI took the initiative to generate suitable hybrids for tropical condition. Hybrid rice now covers 0.5 to 1 million ha in India, 0,3 million ha in Vietnam, 0,3 million ha in Philippines and 50,000 ha in Bangladesh.

In 2002, collaborative research between IAARD and IRRI identified two promising hybrids, IR58025A/BR827, and IR58025A/IR53942, which was then released as Rokan and Maro, respectively. Then other varieties generated by IAARD using IRRI parental lines from Hipa3 to Hipa11 were released during the perod of 2004 to 2009 (Table 2). Until 2010, more than 30 varieties were released in Indonesia. Most of the varieties were introduced from China.

- Understanding how the switch in rice varieties would affects planthopper fitness and how planthoppers adapt to new cultivars.
- Develop ecological engineering tools and strategies that will increase arthropod biodiversity and ecosystem services that will provide resilience to rice production systems.
- Understanding virus-vector relationships and ecology to develop strategies that will control vectors, transmission and spread of virus diseases.
- Monitor insecticide resistance using standard toxicological methods and understand how BPH populations respond to insecticide sprays and how the local arthropod biodiversity is affected.

Disease resistant. The population structure of BLB in Java and Bali has been identified by DNA-fingerprints analysis using the restriction fragment length polymorphism marker IS1113. Rice genes controlling resistance to the dominant population of BLB were also found. These are recessive gene xa-5 and the dominant genes Xa-7 and Xa-21. The genes are carried by an isogenic gene common to the IRRI strains IRBB5, IRBB7, and IRBB21. Improvement of IR64 through the incorporation of xa-5 and Xa-7 genes by the backcross method has generated two improved lines Bio 1 and Bio 2 which are then released as Angke and Conde varieties in 2001. Conde (Bio 9-BC5-MR-4-5-KN-5-1) is a crossing between IRBB7/IR64^{6}, and Angke (Bio 8-BC5-MR-3-5-2.PN-1) is a crossing between IRBB5/IR64^{6}.

For upland environments, scientists identified the population structure of blast fungus (*Pyricularia grisea*) in five locations, namely Sitiung, Palembang, Tamanbogo, Sukabumi, and Garut. Studies continue to incorporate blast-resistant genes into upland rice varieties through double-crossing methods using fifth-generation plants.

BPH resistant. Prior to the brown planthopper (BPH) outbreak in the middle of 1970s, the rice planted area was dominated by Pelita 1-1, a national rice variety. The IRRI breeds IR26, IR30, and IR32 proved to be resistant to the BPH Biotype 1 and replaced Pelita 1-1 until the more virulent BPH of Biotype 2 attacked the rice crop. IR36, resistant to Biotype 2, was released in 1978 and dominated the rice area until late 1980s. Following its release in 1980, Cisadane rice variety, which has good quality and higher yield than that of IR36 was accepted well by farmers.

IR64 which was released in 1986 is a short mature variety having good eating quality. This rice variety became popular to farmers in a short period of time and is dominant in major rice producing areas. Recent reports suggested that this variety became susceptible to Tungro viral disease and to BPH. Developing rice variety resistant to either one or both of these pest and disease must be anticipated following the experience with that of IR26 and IR30. Meanwhile, national varieties such as Ciherang and Inpari have gained popularity with some farmers.

Research is needed to develop sustainable planthopper management strategy such as:

- Understanding farmers' pest management decisions, their attitudes, beliefs and practices.

Figure 1. Two IRRI senior researchers, Dr. K.L. Heong (Insect Ecologist) and Dr. Finbarr Horgan, presented paper on Biodiversity, Ecosystem Services and Sustainable Planthopper Management and Insect Resistance in rice during a seminar on 30 August 2010 at ICFORD

Between 1995 and 1999, IAARD and IRRI scientists collected 592 samples of cultivated rice and six species of wild rice from various locations including Central Kalimantan, Nangroe Aceh Darussalam, East Nusa Tenggara, Maluku, Sulawesi and Papua. Local technicians underwent training in field collection and conservation of rice samples.

A duplicate of this collection is available at IRRI, help ensure the continued survival of such traditional varieties as Rojolele and Pandanwangi. National institute will further explore the potential of these traditional varietes in generating new and improved varieties that are both bountiful and delicious.

Modern rice varieties

The use of improved modern varieties, fertilizers, and irrigation had made significant contributions to the national rice production. Between 1970 and 2010, Indonesia's average rice yield increased more than double, from 2.35 t/ha to 5.03 t/ha.

In addition to having high yield potential, modern varieties mature quickly in 105-115 days compared to that of traditional varieties which mature in 150 to 180 days. The release of these modern rice varieties enable farmers to quantify the benefits of double transplanting so as to optimize land utilization, in irrigated rice systems, triple transplanting of rice-rice-rice, rice-rice-maize/soybean, and other similar high-income of intensive cropping pattern. Another important benefit of modern varieties is the resistance to pest and diseases that allows farmers to reduce pesticide application.

From 1967-2009, Indonesia released 250 rice varieties consisted of irrigated lowland rice, sticky rice, hybrid rice, new plant type, upland and dry area, and tidal swamp area. Rice breeding program in Indonesia is carried out in Indonesian Center for Rice Research (ICRR), National Agency for Nuclear Energy (BATAN), Indonesian Institute of Sciences (LIPI) and Universities. Sixty two Indonesia rice varieties are pure IRRI lines which were released as Indonesia varieties. The rest of rice varieties were bred using IRRI genetic material as parental line by Indonesian rice breeder. About 70-80% of rice varieties planted by farmers in Indonesia are IRRI lines or derived from IRRI lines crossing.

Exchange genetic materials

Exchange genetic materials made possible through the International Network for the Genetic Evaluation of Rice (INGER), a 35-year old partnership among NARES of rice-growing countries around the world and international agricultural research centers such as IRRI.

INGER is a global model for the exchange, evaluation, release, and use of genetic resources. The network abides by the International Treaty on Plant Genetic Resources for Food and Agriculture that fosters international cooperation and open exchange of genetic resources.

In collaboration with NARES of many countries, IRRI has assembled the International Rice Gene Bank which preserves more than 110,000 accessions. As agreed in the initial convention, researchers from around the world have access to this diverse storehouse of rice germplasm.

Between 1970 and 1999, IARRD assembled a seed collection of 11,720 local or traditional varieties, comprising of 8,851 accessions of lowland varieties, 2,134 from upland areas, and 735 from tidal swamps. Those accessions consisted of 10,034 indica and 1,686 javanica rice.

Duplication of rice germplasm collection storage at IRRI for conservation of local variety such as Rojolele and Pandanwangi

(2) National strategy and framework plan for hybrid rice development
(3) Abiotic stress tolerance particularly submergence, drought, and low temperature damage in high elevation areas
(4) Support to implementation of integrated crop and resource management in the target areas through IRRC and Rice Knowledge Bank
(5) Support of dissemination of post harvest technology

B. Collaborative Research

(1) Strengthening research capacity on the development and safe use of transgenic rice in Indonesia
(2) Improving grain quality and nutritional value of rice (including a support to develop grain quality laboratory.
(3) Functional genomics and molecular breeding, with emphasis on drought, blast and P deficiency
(4) Development direct seeding and water-efficient irrigation technologies
(5) Strengthening linkage between research and development: initiatives to accelerate delivery and impact of technology through the Rice Knowledge Bank
(6) Strengthening collaboration and capacity building in socio-economic, impact assessment and policy studies
(7) Climate change research (climate impact and vulnerability; heat tolerant rice; short maturity)
(8) Developing biodiversity and environment sustainability indicators and assessing multi-functionality of rice production systems
(9) "Healthy" canopy management for high yield

C. Human Resources Development

(1) Sandwich type post graduate degree training
(2) Shuttle scientist
(3) On-the-job/intern training
(4) Scientist exchange
(5) Short course training
(6) In-country training

Another MOU, signed in 30 August 1984, underlined the importance of genetic evaluation and utilization for different ecosystems, particularly uplands, high-elevation areas, tidal wetlands, and swampy areas. It also covered reseach collaboration in water management, sharing of genetic resources, scientist exchange, and co-publication.

In recognition of the institute's role in helping Indonesia achieve rice self-sufficiency in the 1980s, President Suharto presented the Bintang Jasa Utama, the country's highest merit award, in 1989, to IRRI's than Director General, Klaus Lampe.

The following MoUs, each in effect for a five-year period, were signed on 20 April 1990, 16 November 1995, 4 December 1999, 21 June 2001, and September 2006. It covered various aspects of research and human resource development. Genetic evaluation and utilization for various ecosystems and management of rice genetic resources remain as top priorities, in addition to forecasting pest and disease epidemics, improving soil quality, and technology generation and promotion.

The latest Indonesia – IRRI workplan meeting was held in March 2007 in Jakarta. It was agreed that for the next three years (2007-2009), Indonesia and IRRI will focus on the following topics:

A. Support to the Indonesian Rice Production Increase Program

    (1) New Plant Type and advanced inbred for high yield potential, grain quality, and resistance to pests

Signing an MoU of research collaboration between IAARD and IRRI at the IRRI HQ Los Banos, Philippines, September 2006

Indonesia – IRRI Collaboration

The Indonesian government recognizes the importance of research and technology in national development. Therefore, the government has granted substantial support for such programs, especially in agriculture. The national rice research institutes have been collaborating with their counterparts overseas, in particular with the International Rice Research Institute (IRRI).

Collaboration between the government of Indonesia and IRRI formally began on 20 December 1972, when both agreed to cooperate in the improvement of rice research through Indonesia's National Rice Research Program. Six years later, a memorandum of understanding (MoU) was signed by Director General, IRRI, and Director General, IAARD.

The MoU gave the highest priority to the genetic evaluation and utilization of rice, implementation of improved rice-based cropping systems, development and testing of machinery for small-scale farming, and formal academic training and specialized non-degree training of Indonesian scientists. At this early stage, support was received from various sources such as the Ford Foundation, the United States Agency for International Development, the Japan International Cooperation Agency, and the Government of the Netherlands.

IRRI Indonesia Office is located in ICFORD building at Jalan Merdeka 147, Bogor, Indonesia

Indonesia Achievement in Rice Production

An effort to achieve the national food supply was started in late 1960's with the beginning of the First National Five Year Development Program. The program was supported by a strong political will of the government. During these times, the government prioritized developing a national capacity building such as construction of irrigation facilities in Java and other islands, construction of fertilizer plants to meet the national demand of fertilizers, and massive manpower development program through the increase in number and capacity of field extension workers.

After several five years of development program, Indonesia achieved self sufficiency in rice in 1984. Thereafter, Indonesia started to begin importing rice again. As the world's fourth-most-populous country and with annual population increase of 1.5%, Indonesia requires corresponding annual increase in food supply. For example, from 2007 to 2010, the average of annual rice production was 60.6 million tons from a harvest area of 12.3 million hectares, with an average annual increase in production of about 5%, of which about 2.5% derived from the increase of land productivity (Table 1).

The current increased of national rice production was due partly to a wide adoption of modern released rice varieties, better supply of fertilizers and in the last couple of year due to a special effort to encourage farmers to adopt rice technology through farmers' field school of integrated crop management (ICM Field School). Through this program the government continues to subsidize farmers with lower price of urea, NPK Compound fertilizer, and seeds. Under ICM FS, field extension workers underwent various levels of training for trainer (TOT) of ICM Field School.

Table 1. Rice harvest area, productivity, and production, Indonesia, 2006-2010

Item	2007	2008	2009	2010*
Harvest area (ha)	12,147,637	12,327,425	12,878,039	13,118,120
Productivity (t/ha)	4.70	4.89	5.00	5.03
Production (t)	57,157,435	60,325,925	64,329,329	65,980,670
Growth/year harvest area (%)	3.06	1.48	4.47	1.86
Growth/year productivity (%)	1.84	4.02	2.07	0.60

Source: CBS, 2010. * Data year 2010 is the third forecast figures

IRRI was established in 1960 through the Rockefeller and Ford Foundation with an objective to conduct research that helped developing countries grow more rice. The institute was one of the 16 international agricultural research centers supported through the Consultative Group on International Agricultural Research (CGIAR). The institute's interdisciplinary approach was based on close collaboration with advanced laboratories worldwide and National Agricultural Research and Extension Systems (NARES).

Working together, the scientists sought knowledge on the impact of intensified cropping system on the soil resources, improve understanding of rice-pest-co-evolution, and acquiring new insight into the effects of global climate change.

Country facts and rice situation

Item	Value
Populations, 2010 census (millions)	237.556
Annual growth population in last 10 years	1.49%
Gross National Income (US$) 2009	2,230
Rural population (%) 2009	47% (109,049,272)
Life expectancy (year)	71
Total farmers (labor/farm worker) (2009)	39,389,442
Total rice area ('000 ha)	7,790
Average rice yield (milled rice) (2009) (t/ha)	5.00
Total rice production (2009) (ton)	64,398,890
Area harvested rice (2009) (ha)	12,883,576
Number of government extension workers (2008)	28,879
Rice consumption (milled rice) (ton)	38.9
Rice production cost per ha (US$)***	Rp 4.000.000 (US$430)
Annual rice consumption per capita (kg)	139

Sources: FAOSTAT, World Bank, and Indonesia Central Bureau of Statistic

National Rice and Challenges Ahead

Indonesia with a population of 237 million people in 2010 is the world's fourth-most-populous country. Populations increase by a 1.5% annually requires corresponding increase in rice supply. From 2006 to 2009, the average of annual rice production was 59.1 million tons from a harvest area of 12.3 million hectares. Although the share of rice to farmers' income is relatively low, the role of rice is very strategic. Rice influences strongly the economic and political stability. For example, the increase of rice price up to 10% may cause high inflation rate.

However, during 2006-2009, annual per capita consumption of rice changed a little, that of roots and tubers decreased by about 6%, fruits increased about 3%, poultry about 9%, and wheat about 10%. Notably, during the economic-crisis in 2009, consumption of rice *per capita* declined at the least among those eight food groups. Efforts to sustain rice production must thus continue with high priority.

Indonesia's agricultural development program has three main aims: (1) increased national food security through higher production and lower food imports, (2) increased added value and competitiveness of agricultural products, and (3) improved quality of life and less poverty for farming households – achieved through higher productivity. Rice – with its strong influence on economic and political stability – is a dominant agricultural commodity.

The primary objective of rice research on increasing yields and land productivity had taken an additional challenge. That is how to simultaneously increase the productivity of labor, water and chemical inputs while preserving natural resources and protecting the environment.

The challenge to the scientific community is how to help maintain a continuous increase in food supplies despite of limited natural resources and declined arable land. The soil, water and biotic resources from which all food are originated must be protected.

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Preface

The Indonesian government, through various policies, has paid great attention to fulfill food need of its steadily rising population. Strong support for research activities has resulted in better information and improved technology for food crop production. These have significantly contributed to the increase of food production, particularly rice crop during the past decades.

Both IRRI and Indonesia have common interests in accelerating rice research systems, rice-based farming systems, and promoting rice technology to increase and sustain rice production. Great challenges of rice production are ahead of us especially in dealing with climate change, diminishing natural resources and more limited available, and increasing population of pests and infection of diseases. More than 30 years, Indonesia-IRRI research collaboration has generated some rice technologies that are expected to help in increasing rice production so that Indonesia could maintain national food security and enjoy self-sufficiency in rice.

Presently, submergence and drought tolerance rice varieties are being developed under CURE and the Green Super Rice program. Through this program, it is expected that Indonesia will regain in achieveing and maintaining self-sufficiency in rice. Efforts are being made to improve nutritive values of rice varieties in providing more micronutrient for rice consumers. These include iron and zinc-rich rice and golden rice that contain high provitamin A. Aside from this current program, some rice production technologies have also been generated.

This publication briefly presents highlights of the cooperation activities, achievement, and ongoing research. We are thankful to all those who have supported and participated in this cooperation

Bogor, December 2010
Director of Indonesia Center for Food
Crops Research and Development

Dr. Hasil Sembiring

Rice for Food Security

Indonesia Center for Food Crops Research and Development
International Rice Research Institute
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