WEATHER REPORT

The highest temperature of 35.6 °C was recorded on 11th Jul, 2011. The lowest maximum temperature of 16.9 C was recorded on 2nd Jan, 2012. Annual recorded during the year 2011-12 was 1576.8 mm. the monthly rainfall was highest in the month of Jun, 2011 (383.2 mm) whereas Dec 2011 was driest, month with 0 mm rainfall. The maximum relative humidity of 100% was recorded on 14th Jun, 2011, 9th Aug, 2011, 17th and 16th Sep, 2011 and 2nd Jan, 2012 whereas the minimum relative humidity of 17th % was recorded on 12th Feb, 2012. Maximum daily average wind speed of 11.8 km/hr was observed in the month of 15th Mar 2012 (Table 1).

Table 1 Agro-meteorological data (monthly average) from Apr'1 to Mar'12

Month	Temp (^{0}C)		RH (%)		Wind direction (deg)		Wind speed (km/h)	Total rainfall (mm)	No. of rainy days	Bright Sunshine (hrs)
	Max	Min	Morning	After-noon	Morning	After-noon				
Apr	28.2	15.5	81.0	53.3	156.0	263.3	5.8	38.9	5	5.8
May	28.2	19.2	85.8	68.0	141.8	226.6	5.2	274.7	13	5.2
Jun	29.8	22.0	92.2	80.5	143.7	24.10	3.4	383.2	20	3.4
Jul	30.7	22.0	92.3	77.5	141.5	258.5	3.5	298.8	14	3.5
Aug	30.4	21.8	92.9	77.6	86.6	212.9	3.0	278.4	18	3.0
Sep	30.3	21.4	89.4	70.1	84.3	222.5	4.5	146.6	10	4.5
Oct	28.7	17.8	87.3	61.5	116.9	213.2	5.9	49.3	4	5.9
Nov	27.0	9.2	86.2	47.6	143.8	194.5	8.3	1.3	0	8.3
Dec	24.0	5.6	87.5	48.0	205.3	235.0	6.9	0	0	6.9
Jan	22.0	5.2	84.6	50.0	180.6	249.0	5.9	26.4	3	5.9
Feb	26.0	5.8	75.8	35.2	154.1	261.0	7.5	6.0	1	7.5
Mar	28.7	11.1	79.8	44.5	145.2	258.7	7.1	73.2	6	7.1

RICE

Breeding for medium duration rice genotypes suitable for lowland and upland conditions of Manipur

Selection of parents and making of crosses

For hybridization programme, parents were selected on the basis of yield, blast resistance and other quality characters. Following crosses were attempted during *kharif*, 2011 in order to create variability and transfer of desirable traits: RCM-9 x RCM-10, RCM-10 xRCM-9, RCM-10 x RCM-13(B), RCM-23 X RCM-9, Bhalum-1 x RCM-9, Bhalum-3 xRCM-23,Bhalum-3 XRCM-9, Bhalum-1 x Phougak, Chakhao x RCM-23, RCM-9 x RCM-13(B), Swarna x RCM-23 and Swarna x RCM-9. F1 generation will be raised in *kharif*, 2012.

Selection of promising lines from segregating and subsequent population

F_4 populations from the crosses *viz.*, IR-64/SARS-9, IR-64/ Phungphamah, IR-64/SARS-1, IR-64/Phougak, KD-2-6-3/Yungra Makrei, KD-2-6-3/Wang shim Makel and KD-2-6-3/Phougak (Figs 1a &b) were evaluated for yield, diseases, insect resistance, and other parameters. About 200 lines were selected from F_4 segregating population for desirable characters under low land condition. Population of F_6 generation from four crosses Viz; RCM-9 x Manuikharamui, RCM-10 x Akhanphou, Taothobi x RCM-10 and Akhanphou x RCM-10 was raised in low land rainfed area and evaluated for yield, resistance to disease and insect-pests and other parameters.

Figs 1a & b Promising segregants of IR-64 x Phougak

Station trial on high yielding medium duration rice genotypes

A preliminary yield trial was conducted with 18 advanced breeding lines of rice along with 2 popular checks under lowland transplanted conditions. Six promising lines *viz*., MC-34-5-12-33-03-26 (8402 kg/ha), MC-34-1-30-75-11-131 (8263 kg/ha), MC-34-9-7-7-77-96-02 (8194 kg/ha) and MC-34-4-13-45—82-70 (7939 kg/ha) showed significantly higher yield than the local checks RCM-9 (6661 kg/ha) and Leimaphou (6018 kg/ha).

In another trial, eight advanced breeding lines of rice along with three popular checks were evaluated under lowland transplanted conditions. One line i.e. MC-34-10-3-30-75-16-1 was promising and showed higher yield (7972kg/ha) than the all the local checks *viz*., RCM-10 (6889 kg/ha), RCM-9(6388kg/ha) and Leimaphou (5916 kg/ha). This line was moderately resistance to neck and leaf blast.

Evaluation of rice genotypes for paddy cum fish culture in *kharif*

Twenty five advance lines of rice were tested along with two checks. Majority of them were tall types for the purpose of paddy cum fish culture. All those lines were tested for yield, tallness, strong culm, reaction to disease and insect-pests. Entries *viz*., MC-34-4-9-1-23-46 (7577 kg/ha), MC-34-1-26-28-8-4 (7355 kg/ha), MC-34-1-11-1-89-03-16 (7345 kg/ha), MC-34-7-1-14-13-56-46 (7222 kg/ha), MC-34-7-6-2-72-92-90 (7222 kg/ha), MC-34-7-18—1-101-16-36 (7000 kg/ha), MC-34-4-4-1-5-51-11 (7000 kg/ha), MC-34-10-9-34-34-6

(6750 kg/ha) and MC-34-4-3-9-31-18 (6533 kg/ha), were found promising as compared to checks varieties i.e. KD-2-6-3 (5905 kg/ha) and Akhanphou (5860 kg/ha).

Evaluation and maintenance of rice germplasm

Two hundred forty lines of rice collected from Manipur, Nagaland and Arunachal Pradesh were evaluated for yield and yield attributing traits. The germplasm is being maintained for utilizing in further breeding programme

Akhanphou - a high value rice germplasm of Manipur

A popular local cultivar, Akhanphou having tolerance to biotic and abiotic stresses, adaptation, and desirable taste is being used in breeding programme of the centre was sent to DRR, Rajendranagar, Hyderabad for precise phenotying and genotyping for blast. It was found completely resistant for leaf blast under uniform blast nursery (UBN) continuously for two seasons. It was screened at Biotechnology laboratory of DRR with markers linked to seven known blast resistant genes *viz., Pi1, Piz, Pita/Pita2, Pi40, Pi54, Pi9* and *Pi2* (Table 2) and marker allelic pattern was compared with the monogenic lines containing those particular genes and it was found positive for four major blast resistant genes. It was also found tolerant to low phosphorus conditions when screened at DRR and genotyping for presence/absence of *Pup,* only QTL known to have been reported till date to confer low-P tolerance. The work to find it out in Akhanphou is under progress. Therefore, keeping in view the above facts this highly valuable local germplasm will be protected by registering with NBPGR, New Delhi.

Table 2 Genotyping data of Akhanphou for seven linked markers for rice blast

Genotype	***Pi1***	***Piz***	***Pita/Pita2***	***Pi40***	***Pi54***	***Pi9***	***Pi2***
Akhanphou	-	-	+	+	+	-	+

RCM 13: A pre-released short duration rice culture

RCM 13 (IET No. 22828), a derivative of the cross Leimaphou x Akhanphou having a short duration (days to 50% flowering-75days) was found suitable for pre-*kharif* /early *kharif*/main *kharif* (contingency variety). It has desirable soft cooking (low amylose content-11.70%) quality characters preferred by the people of northeastern hill region. So far as low amylose content has been reported in traditional land races. It is a first evolved culture having very low amylose content.

Fig 2 Short duration rice culture RCM 13

It has several merits over traditional long duration land races as it matures in about 95-105 days and it will be very much suitable for different cropping systems. Seeds demand has been increasing in valley districts due to its unique taste and short duration nature. Proposal for release of this variety for Manipur state will be made shortly after field trials in valley district.

AICRIP

Three upland trials of AICRIP *viz.,* AVT-1-U-H (10 entries), AVT-2-U-H (7entries), IVT-U- H (10 entries) were evaluated for their comparative performance under upland (Direct seeded) conditions at Langol farm of ICAR Research Complex for NEH Region, Manipur Centre during *kharif* 2011. In AVT-1-U-H, entry HPR-2559 (3397kg/ha), was observed for significantly higher yield than the local check, Bhalum-1(2687kg/ha), as well as National check Vivekdhan-154(2587 kg/ha). In case of AVT-2-U (H), entry RCPL-1-115 (3720 kg/ha), was observed for significantly higher yield than the local check, Bhalum-1(2096kg/ha), regional check Sukaradhan-1(2683kg/ha) as well as national check, Vivekdhan-154 (2763kg/ha). Entry VL7852 (2677 kg/ha) was observed for significantly higher yield than the local check Bhalum-1(2096 kg/ha). In case of IVT-U (H), National check, Vivekdhan-154 (3160 kg/ha), was observed for significantly higher yield than the local check, Bhalum-1(2218 kg/ha). No other entries were observed for higher yield than the national check. Vivekdhan-154 was also observed as extra early type as 50 % flowering was observed in 65 days old crop.

Research Complex Regional Trial (RCRT)

Low land (Transplanted)

Three trials *viz.,* RCRT LL-1(18 entries) RCRT LL-II (14 entries) & RCRT LL-III (13 entries) were conducted under low land transplanted conditions in Manipur valley during *kharif* 2011. In LL-1, two entries *viz.,*, RCPL-1-401 (6383 kg/ha) and RCPL-1-400 (6377 kg/ha), showed significantly higher yield as compared to the RCM-9 (5157 kg/ha). Both of those entries were at par with RC Maniphou-11(5576kg/ha). In LL-II trials, none of the entry was found significantly higher yielding than the local check, RC Maniphou-11(4572 kg/ha). In LL-III trials, only one entry i.e., RCPL-1-471 (5822 kg/ha), recorded significantly higher yield over the best check RC-Maniphou-11 (4791kg/ha).

Upland (Directed Seeded)

Two trials *viz.*, RCRT UL-I (9 entries) and RCRT UL-II (10 entries) were taken under upland conditions at Langol farm during *kharif* 2011. In UL-I trial, Bhalum-3 (3380 kg/ha) and RCPL-1-130 (3197 kg/ha) gave significantly higher yield than the best checks Bhalum-1 (2305 kg/ha) and RCM-5 (2249 kg/ha). In case of UL-II, Bhalum-3 (3012 kg/ha), showed significantly higher yield as compared to the best checks Bhalum-1 (2305 kg/ha) and RCM-5 (2248 kg/ha).

Frontline demonstrations on rice var. RC Maniphou-11

The FLD programme (Fig 3) was undertaken during *kharif*, 2011 with released high yielding, blast resistant rice variety; RC Maniphou-11(IET No. 20193). Ten demonstrations were taken in Imphal West and East, Churachandpur, Tamenglong and Ukhrul districts. Fifteen progressive farmers were selected in consultation with the State Agricultural Department. Leimaphou a high yielding, popular variety (taste preference) was taken as check variety. RC Maniphou-11 gave a yield advantage of 43% over the check. The highest yield (7.50t/ha) was obtained in Imphal West with average yield of 6.85 t/ha. Since there is shortage of good quality high yielding varieties with locally accepted taste, it would help greatly in increasing the rice production of the state.

DISEASES

Evaluation of rice germplasm against different diseases at seedling stage

Three hundred and thirty six lines/varieties of germplasm were evaluated for their reaction against leaf blast, bacterial blight and brown spot diseases. For leaf blast the disease score varied from 1 in Allechiso, Chupu wingrice, Apaghi june, Makhara 11, Kemeste, Chala TSSIA, Otsok Khira, Chingphou, Koyajang, Tengu bepher, Charailu abd Atukumupu to 9 in Bhuman, RCM-12, RD-5-2-8, TSSOK, Myku Duikungmei, SL-76. All other lines were free from blast. All the lines were free from brown spot diseases except Sapal maso and Maisajang in which disease score of 2 and 1 was recorded respectively. The highest bacterial leaf blight disease score of 9 was recorded in Chingphou, Thangmoi, Chakhao local and SS/Chakhao . The lowest Bacterial leaf blight score of 1 was observed in Younyo Kangru, Khatuthi, Matamah, Chingphouren amubi, Khangamra, Runya, Acefoghsyo ripit, Chupu wingrice, Desek youso, Apaghi june, Moirangphou Khonembi, Basmati-370, Rozose phek, Kenyo, Ztsukmutasa, MC26-6-2-3, Naga special-2, Imsatang makongching, Laza TSSOK,

Neikado ulhn Tsia and Chinapati. Out of the 197 entries screened under field conditions, most of them had bacterial blight infection. The highest score of 9 was recorded in TekumTssok, kene, Wazhuho phek, Chah Tssia, Tsok Mayko follwed and Yunyokan stco followed by 7 in Kere Phek, Acefoghsyo Ripit, Ebemestsi, Makhara II, Manong Kangbu, Shitharia Maha, Ahutnei, Thekrulha, ZtsukMuasa, Khemaru, Laza Tssok, Bali red, Keme Yaisha, Rosole, MipinRonga 1, Bhobu Kangbu, Manon Tsok, MC-21-2-19-8, Bali White, Etsaro, Reto Masojang, Gumdhan, Tsupuri, Sangbhuman, DuikungmeiMalon Tsok, and Rishegri. Other gerrmplam entries exhibited score of 1, 3 and 5. The brown spot score varied from 8 in Kerebe Phek, Laza Tssok, Laispoh, Hokha Tsok and Jaksemla to 7 in Allechisho, Chupu Wing Rice, Phugcham Mah, Tekum Tssok, Wazhuho Phek, Mipin, Chalha Tssia, Ronga 1, Leisemjang, Aya mao mah, Meron Tssok, , Phouren , Pondejhum, Mayamoisoida, Yengulo, Kishal, Rishegri, Alechiso, and Machan Kaoyeng . The entries on which leaf blast was recorded at nursery stage were free from the disease after transplanting.

Screening of Rice Entries under National Screening Nursery (NSN–H) against Multiple Diseases

Seventy seven entries (NSN-H) sent by DRR Hyderabad were screened for multiple diseases. All the entries were free from leaf blast. The neck blast score varied from 7 in RASI and Improved Samba Mahsuri to 5 in Vikramarya, CH45 and entry 3007 (VL31618) to 1 in entries 3510 (VL8094), 3009 (VL31577), 3306 (VL31726) and 3310 (SKAU 410). The Bacterial blight reaction in different entries varied from 9 in 3510 (VL 8094) to 7 in entries 3508 (VL8051), 3604 (VL8292), KD263, 3102 (HPR2589), 3108 (VL31450), HPR2143, Improved Sambha Mahsuri and RASI. The entries exhibiting score of 1 were 3509 (VL8116), 2801 (HPR 2529-4), 2808 (VL31449), 3401 (VL7954), 3407 (VL7852), 3602 (VL8204), 3610 (HPR2645), 3206 (VL31401), 3207 (VL31348), 3004 (UPR3575-11-2-2), 3006 (VL31616), 3007 (VL31618), 3011 (HPR2615), 3301 (VL31724), 3304 (UPR3573-4-2-1), 3305 (VL31600), 3308 (VL31611), 3314 (HPR2612), 3105 (VL31452), Sukaradhan-1, Vivekdhan-154 and IR-50. The disease score for brown spot varied from 7 in entry HPR 2656 to 6 in HPR 2143 followed by 5 in HPR 2618 to 4 in entry RP2421 and KD 263. The reaming entries were either free from brown spot or exhibited a score of 1. All entries were free from sheath rot and rice tungro virus.

MAIZE

Evaluation of genotypes under foothill conditions

Thirty four genotypes of maize along with two checks were evaluated for yield and its component traits. Analysis of variance showed highly significant genotypic differences for yield and its related traits except ear diameter, number of kernel rows and 100-kernel weight. Genotypes BC1 and BC5 recorded shorter duration for days to 50% tasseling and days to 50% silking in comparison to both checks Pusa Composite and Local Red. The lowest plant height was measured in genotype BC5 (132.1 cm) followed by SC 4 (149.7 cm). The highest seed yield/plant was recorded in the genotype BC3 (120.1g) followed by SC7 (113.3 g). In genotype BC3, seed yield/plant was contributed by the highest plant height (236 cm) while the maximum ear length (15.4 cm) and cob weight (138.5 g) had significant direct contribution to the seed yield/plant (113.3 g) in the genotype SC7. The genotype M-15 showed the highest kernel rows/ear.

Collection of maize germplasm lines from northeastern hill regions

Sixty nine germplasm lines of maize were collected from three major states of NEH regions *viz.*, Manipur, Nagaland and Sikkim. Those lines had extensive variability for yield related traits such as length of cob, diameter of cob, number of kernels/row and number kernel rows/ear. The germplasm (Fig 4) will be useful for breeding programme.

Fig 3 Variability in maize germplasm

Balanced nutrient management for improving productivity of maize

The effect of organic manure (FYM) and fertilizers including micronutrients (Zn, B) on performance of maize was studied. There were eight treatment combinations: T_1 = control; T_2 = 10 t FYM ha^{-1}; T_3 = 100% NPK; T_4 = 100% NPKZnB; T_5 = 100% NPKZnB + 10 t FYM ha^{-1}; T_6 = 100% NPKZnB + 5 t FYM ha^{-1}; T_7 = 50% NPKZnB + 10 t FYM ha^{-1} and T_8 = 50% NPKZnB + 5 t FYM ha^{-1}. 100% NPKZnB represented 120 kg N; 80 kg P_2O_5; 60 kg K_2O; 5 kg Zn; 1 kg boron. The results showed that different combination of organic and inorganic nutrient sources significantly increased maize grain yield over the control; on average, the magnitude of increase was 36.4%. However, there was no significant difference in plant height, number of cobs per plant, cob diameter and cob length. The highest yield was recorded with T_5 followed by T_6, T_7, T_8, T_4, T_3, T_2 and T_1 (control) in decreasing order, which indicated that the integration of FYM and mineral fertilizers including Zn and B was

more beneficial in increasing maize yield as compared to only either FYM or inorganic fertilizers.

PULSES

PIGEON PEA

Evaluation and advancement of segregating generations of interspecific crosses of pigeon pea

F_3 and F_4 progenies of two interspecific hybrids along with their parents were screened against pod borers under natural field conditions. Those progenies were derived from crossing between pigeon pea cultivars *viz.*, ICPL-88034, UPAS-120 and its wild relative i.e., *Cajanus scarabaeoides*. The test material was kept free from any insecticidal spray throughout the crop season. Least pod damage was recorded in *C. scarabaeoides* (4.39%). It also showed fully developed seeds/pod with the highest seeds/pod (7), but recorded lowest pod length (2.7cm) and seed yield/plant (3.3g). Out of the 288 F_3 progenies, 52 progenies were found promising, derived from the cross ICPL 88034 x *C. scarabaeoides* and UPAS 120 X *C. scarabaeoides*. A promising progeny 10268-1 showed maximum number of primary branches/plant (19), high seed yield/plant (28.90 g) and lesser pod damaged (10.71%). Maximum number of pods/plant (189) was observed in the progeny 10254-2. Seeds/pod ranged from 3.4 to 5.6 in F_3 promising progenies of both interspecific crosses. Whereas, damaged seeds/pod was found to vary from 0.0 to 0.2. The highest seed yield/plant was 37.67g with minimum pod damage (7.25%) and damaged seeds/pod (0.0) in the progeny 10258-2 of the cross UPAS120 x *C. scarabaeoides*. Other characters such as plant height (154cm), primary branches/plant (8), pods/plant (138), seeds/pod (5) and pod length (5.8cm) were also desirable in the same progeny. A promising progeny 10129-3 showed the lowest pod damage (3.3%) and damaged seeds/pod (0.0), although pod length was higher (6.9 cm) with seed yield/plant (15.38 g). Total 236 F_4 progenies, derived from the interspecific crosses ICPL 88034 x *C. scarabaeoides* and UPAS 120 X *C. scarabaeoides* were selected for yield and its attributing traits but more emphasis was given for selection of the lowest % pod damaged and damaged seeds/pod. Out of them**,** 29 promising progenies showed the least percentage of pod damage (4.26-10.00) by pod borers and almost had lower % of seed damage by Bruchid (storage pest). Some progenies were free from damage by Bruchid. However, those progenies were lower seed yielding (4.4- 14.15g/ plant) except two progenies (progeny No. 232-2 and 230-181-1). Four progenies *viz.*, 123 (2)-1, 235-4-1, 234-3-2, 230-

185-2 showed lesser damage by Bruchid as well as pod borers with other desirable characters such as pods in cluster, hairy pods, long pods etc.

Evaluation of long duration pigeon pea genotypes in foothill conditions

Fourteen genotypes of long duration pigeon pea, collected from Manipur were evaluated under foot hill conditions for seed yield and its contributing characters. Among them, RCMP 6 showed the shortest duration for days to 50% flowering (99 days), shortest plant height (133.1 cm) and the lowest primary branches/plant (7.9). The genotype RCMP4 recorded the highest seed yield/plant (39.5) and maximum number of pods/plant (94). However, RCMP7 showed the maximum plant height (186.9 cm). The highest primary branches/plant was found to be in genotype RCMP7. Whereas, the maximum seeds/pod (5.6) and pod length (7.9 cm) were registered in the genotype RCMP-10. The highest mean pods damaged (26.23%) were recorded in the genotype RCMP1, whereas lowest mean pods damaged was observed in RCMP7 (9.69%) and RCMP9 (9.95%). The highest mean pods damaged was noticed in RCMP18 (56%), whereas the lowest mean pods damaged (22.5%) was found in RCMP-7. Similarly, maximum pods damaged by pod boring weevil was recorded with RCMP-8 (17.5%), while the lowest mean pods damaged was registered in RCMP-16 (2%).

MUNG BEAN

Partial Purification and biochemical characterization of acid phosphatase enzyme from germinated mung bean seeds

Extraction, partial purification and bio-chemical characterization of acid phosphatase in local mung been germplasm (seed) was undertaken as a step towards understanding its properties. The experimental results showed that the protein content and enzyme activity decreased in the partial purification steps, whereas, the specific activity increased in the purification process. In the purification step, specific activity was 1.3 units/mg protein, purification was 2.6 fold and recovery of the enzyme was 58.90%**.** To study the effect of reaction time on enzymatic activity, acid phosphatase activity increased slowly from 10 to 40 minutes of incubation and maximum activity was recorded at 40 minutes and thereafter the activity decreases gradually. The enzyme was found to be active over a wide range of temperature (30-80 ^{0}C) and maximum enzyme activity was observed at 80^0 C. The result showed thermostable property of acid phosphatase. After 80^{0}C, enzyme activity decreased noticeably indicating that the protein undergoes an irreversible denaturation beyond 80^{0}C. In

the study on effect of pH on enzyme activity, it was revealed that the activity increased from pH 3 to 5.2 and the optimum pH was obtained at pH 5.2. In the present study, pH might have influenced the enzyme activity either by changing the ionization of the enzyme substrate complex or various groups of the enzyme molecule which may affect the affinity of the enzyme for the substrate or by changing the ionization of the substrate to the enzyme. The enzyme activity was also measured at different substrate (p-NPP) concentration from 0.1mM to 12mM. The results showed that with an increase in substrate concentration from 0.1 to 0.8mM, there was a corresponding increase in the rate of reaction and linear relationship was obtained at 2 to 14mM. According to Lineweaver Burk hypothesis, both Michaelis Menten Constant (K_m) and maximum velocity of the enzyme (V_{max}) value were calculated. The K_m value was 0.38mM and V_{max} was 1.2 µmoles/min/mg protein. This result shows that mung bean acid phosphatase has higher affinity with p-NPP and therefore favoured reaction rate. Hence, consumption of germinated mung bean would be helpful for adapting organic phosphorous into available phosphorous that involved in many biological functions such as cell growth and division.

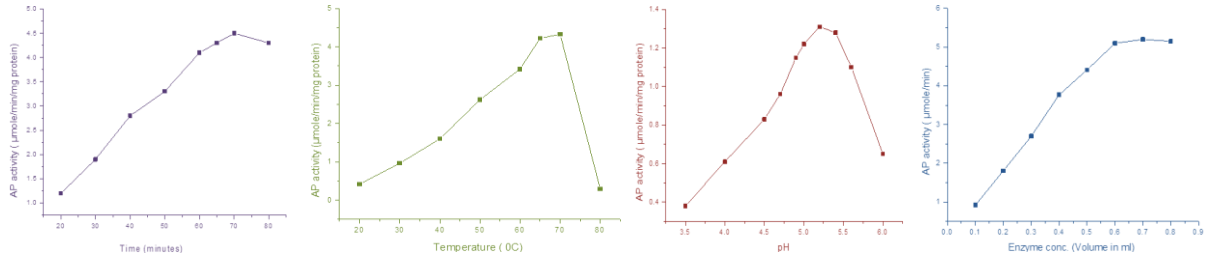


Fig 4 Effect of reaction time, temperature, ph and substrate concentration on acid phosphatase activity

OILSEEDS

GROUNDNUT

Red hairy caterpillar (*Amsacta albistriga*) , leaf minor (*Aproaerema modicella*) , aphids (*Aphis craccivora*), bihar hairy caterpillar (*Spilosoma (Diacrisia) oblique*), tobacco caterpillar, gram pod borer (*Helicoverpa armigera*) were recorded.

All India Coordinated Research Project on Groundnut

Twelve bold seeded groundnut varieties (A series) were tested (Fig). The var. ICGS-76 was the best yielder (3.41 t/ha) followed by NRCG-CS-268 (2.84 t/ha).The lowest yield was observed in var. TPG-41 (1.23 t/ha). In another trial, 14 confectionary groundnut varieties

were evaluated (Fig).The maximum yield was recorded in TG-37-A (3.31 t/ha), followed by ICGS-76 (3.27 t/ha) as compared to lowest yield (1.83 t/ha) in GG-16. Among 18 advanced groundnut varieties (C-series) tested, ICGS-76 gave the maximum yield (3.37 t/ha), followed by K-134 (3.32 t/ha) as against the lowest yield (1.32 t/ha) obtained in GG-14(Fig).Off 18 varieties (D-Series) evaluated (Fig),ICGS- 76 was the highest yielder (3.34 t/ha) followed by NRCGS-268 (2.81 t/ha) as compared to lowest yield (1.07 t/ha) in BG-3.

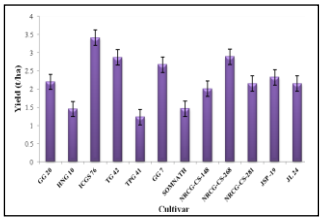


Fig 5 Series A

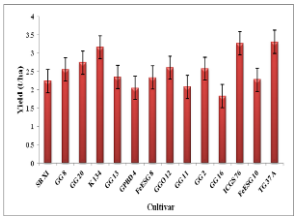


Fig 6 Series B

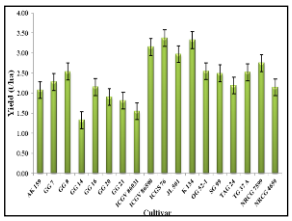


Fig 7 Series C

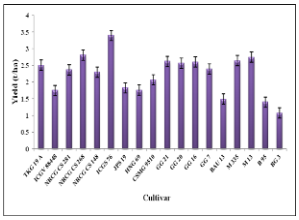


Fig 8 Series D

Boron nutrition in groundnut

The efficacy of different commercial formulations of boron on growth and yield of groundnut (ICGS -76) was studied. The result revealed that the soil application of Solubor @ 10kg/ha was the best and gave maximum yield (3.60 t/ha), followed by soil application of Borosol (3.4 t/ha), Chemibor (3.07 t/ha) and Maxibore @ 10kg/ha (2.90 t/ha) against the lowest yield (2.40 t/ha) in control.

HORTICULTURE

FRUITS

CITRUS

Crop specific DUS testing guidelines

To standardize the DUS testing protocol for three citrus species *viz.*, *Citrus reticulata, C. sinensis and C. Aurantifolia* two orchards of *Khasi* mandarin were selected in Tamenglong district of Manipur. Samples were collected and observations have been recorded time to time as per the standard guidelines. The perusal of the data revealed variation among the growth, yield and quality attributes. The range for length and width of leaf lamina was found to be 6.04-8.10 cm and 2.43-3.31 cm resp. In all cases, petiole wing was present and flowers were found hermaphrodite in nature. More than 4 stamens were observed per petal. Weight, diameter and length of fruits varied between 101.31 to 159.90 g, 38.00 to 70.50 mm and 32.62 to 66.90 mm, resp. Shape of fruit base was observed to be concave collared with truncate shaped fruit apex. Fruit surface texture was smooth, colour of cotyledon and albedo

was green and white, resp. The juice content in endocarp varied between 21-44% with a TSS: acid ratio from 8.34-12.21.

PASSION FRUIT

Organic package for passion fruit based cropping system

A new plantation of passion fruit (Yellow variety) was established on the ridges of the terraces. The intercrops *viz.*, pineapple (Kew), turmeric (Megha Turmeric 1), ginger (Nadia), capsicum (Thai Wonder), brinjal (RCMB-10), okra (BSS-596) and amaranthus (Local) were evaluated under different combinations of bio-organic inputs. The maximum yield of passion fruit (23.63 t/ha), ginger (28.45 t/ha), capsicum (9.27 t/ha) and brinjal (18.45 t/ha) were recorded with the application of Vermicompost (6.5 t/ha) + *Azospirillum* (20 kg/ha) + PSB (20 kg/ha) + AM (65 kg/ha) whereas, highest yield of okra (3.58 t/ha) was found in FYM (20 t/ha) + *Azospirillum* (20 kg/ha) + PSB (20 kg/ha) + AM (65 kg/ha). Recommended dose of inorganic fertilizers showed maximum yield in pineapple (44.21 t/ha) and turmeric (24.60 t/ha). However, both the values are at par with the application of vermicompost + *Azospirillum* + PSB + AM. Irrespective of the crop combinations, the same treatment recorded a maximum gross return (Rs. 5.63 lakhs/ha) from the system based on the prevailing market rate. Irrespective of different treatments, maximum gross return (Rs. 14.54 lakhs/ha) was recorded with passion fruit + capsicum followed by passion fruit + ginger (Rs. 9.13 lakhs/ha). The results indicated a good scope for organic passion fruit cultivation in Manipur with additional income generation (Fig 5) from the high value intercrops.

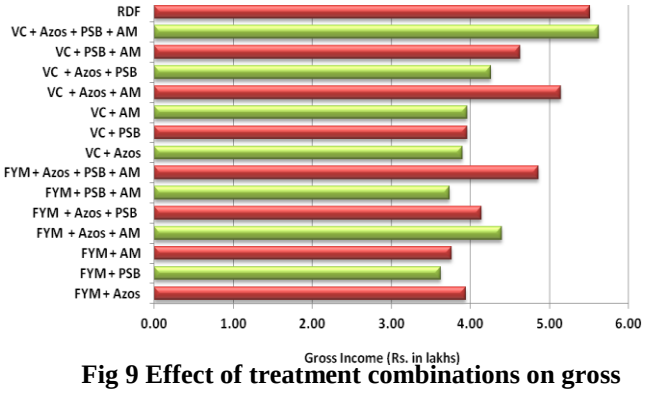


Fig 9 Effect of treatment combinations on gross income

VEGETABLES

TOMATO

For paddy fallow condition in Manipur, high yielding pre-released variety Selection 11 was developed and tested in

Fig 10 MCTR-5

AICRP (V). The trial for Selection 11 at farmer's field is under progress. During 2011-12, MCTR-5 Fig 10 (38.3 t/ha), MCTR-3 (37.9 t/ha), MCTR-4A (36.8 t/ha), RCT-1 (36.8 t/ha), MCTR-4B (36.7 t/ha), RCT-3 (36 t/ha) and RCT-2 (35.5 t/ha) were found promising as compared to check variety DVRT-2 (35.2t/ha).

INSECT PEST

Fruit borer (*Helicoverpa armigera*), serpentine leaf minor (*Liriomyza trifolii*), leaf eating caterpillar (*Spodoptera litura*), aphids (*Myzus persicae*), hadda beetles (*Epilachna vigintioctopunctata*) were recorded.

BRINJAL

Eight promising genotypes of brinjal (long purple type) were evaluated along with released variety Arka Keshav for resistant to bacterial wilt. Among the 8 genotypes, maximum yield (31.94 t/ha) was recorded with RCMB-7, followed by RCMB-10 (30.40 t/ha) as compared to 16.82 t/ha in Arka Keshav. RCMB 10 has been found to be moderately resistant to bacterial wilt. RCMB-10 was proposed for inclusion in the All India Varietal Trial under AICRP (V) during 2012-13.

Fig 11 RCMB-7

COLOCASIA

Experiment was conducted with clonal selections (RCMC 1 to 10) under foothill condition. Among the different clones, the RCMC 1 was found the best for yield (31.37 t/ha), followed by RCMC-4 (29.38 t/ha) and RCMC 5 (28.31 t/ha). The RCMC-5 was found moderately resistant to leaf blight. RCMC-1 was already introduced at farmers' field under OFT programme of KVKs.

BEANS

Collection, evaluation, characterization and documentation of local French bean, dolichos bean and cow pea germplasm of Manipur using morphological and SDS-PAGE

Protein profiling of French bean (30 genotypes), Dolichos bean (15 genotypes) and cow pea (21 genotypes) of Manipur using SDS-PAGE was carried out to reveal the polymorphisms in seed storage proteins and to identify protein based markers for

characterization of genotypes. Seed protein profiling of 30 genotypes of French bean (Fig 8) showed that genotype CK1, RCMF15A, and RCMF4 were comparatively more divergent. Dendrogram based on electrophoretic data clustered the genotypes in two major groups at 56.5% homology. The lower cluster (LC) consisted of 10 genotypes amongst which, 2 genotypes were sub categorized under LC2 and 8 genotypes under LC1. Similarly, the upper cluster (UC) consisted of rest of the 20 genotypes. Three genotypes *viz.,* RCMF20, RCMF 28 and RCMF 35 under LC with maximum homology in seed storage proteins were showed 100% homology and therefore could not be separated on the bases of seed storage proteins. Genotype RCMF7 and RCMF9; RCMF24 and RCMF36 under the UC sub category shown the similar trend. Similarly, a total of 15 dolichos bean cultivars (Fig 9) were characterized by the numerical analysis of seed protein profiles obtained by using SDS-PAGE technique. The numerical analysis of seed protein profiles generated two major clusters (LC and UC) at similarity levels of 27% or above. The first cluster (LC) included only one reference bean cultivar (ICAR1231). The second cluster (UC) was again sub grouped into two categories *viz.* UC1 and UC2. UC2 comprising of four genotypes at similarity values between 50% and 100%. Further, UC1 is categorized into two sub clusters *viz.,,* UC1A and UC1B. The sub cluster UC1B contains five genotypes all have similarity at 100% and UC1A consists of rest of the five genotypes having the highest intra-cluster similarities between 70% and 82%. A number of variability in tested 21 cow pea genotypes (Fig 10) was observed amongst which MCR 4C, MCR 4B and MCR 1293 were comparatively divergent from other genotypes with unique banding patterns. The dendrogram shows distinct separation of the species into two major groups having 39% similarity. Among the two major clusters, the species belonging to the lower cluster (LC) is MCR 4C only. The upper cluster (UC) was further grouped into two sub clusters (UC1 and UC2). UC2 has only the genotype MCR 4B, which have the 42% similarity. UC1 were grouped into two sub clusters (UC1A and UC1B). UC1B consist only MCR 1293 (62% similarity). UC1A were further grouped into two sub clusters ($UC1A_1$ and $UC1A_2$). The first cluster ($UC1A_1$) included 8 reference cow pea cultivars at the intra-cluster similarity values of 70% or above. The second cluster ($UC1A_2$) comprised the 10 remaining genotypes at similarity values between 85% and 100%. In a nut shell, electrophoresis (SDS-PAGE) of seed storage proteins can economically be used to assess genetic variation and relation in germplasm. The specific bands of seed storage protein profiles may be used as markers for identification of the genotypes and to augment future crop improvement program.

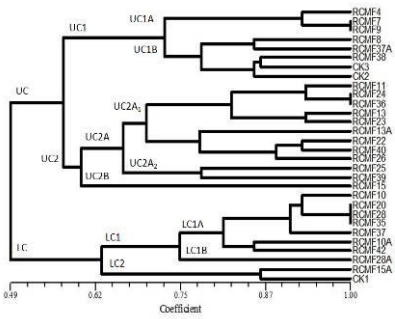


Fig 12 Cluster analysis of French bean genotypes

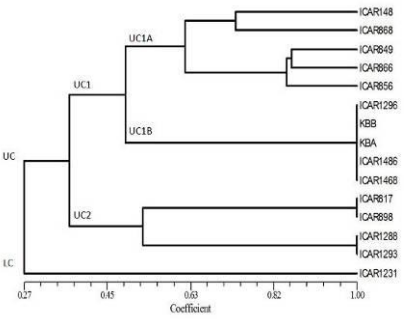


Fig 13 Cluster analysis of dolichos bean genotypes

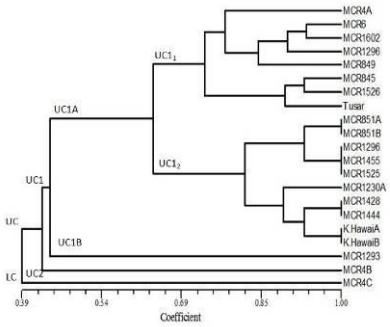


Fig 14 Cluster analysis of cow pea genotypes

SDS-PAGE protein profiling of tree bean genotypes

Tree bean (*Parkia roxburghii* L.) is one of the most important leguminous vegetables grown in the northeastern region. The mature bean seeds are rich in carbohydrates (9.8-13%), protein (24.8-29.7%) and fat (23-35%). A wide variability among the genetic base of this economically important crop is observed in Manipur; but no work for its genetic improvement has been carried out so far. Given this backdrop, seven genotypes of tree bean were collected from different parts of Manipur and characterized analyzing the SDS-PAGE protein profile of the mature seeds. The protocol for extraction of protein from mature seeds and SDS-PAGE protein profiling was standardized. All total 52 bands were scored. The dendogram based on similarity matrix was constructed using the unweighted pair-group method with arithmetic averages (UPGMA) by using NTSYSpc. A wide variation among the genotypes was observed indicating the diversity and scope of improvement of this potential tree legume.

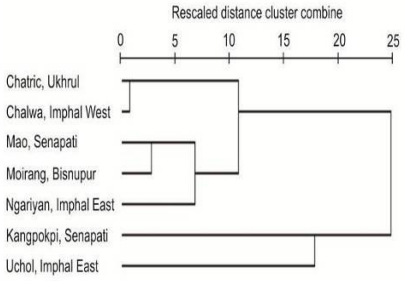


Fig 15 Cluster analysis of tree bean genotypes

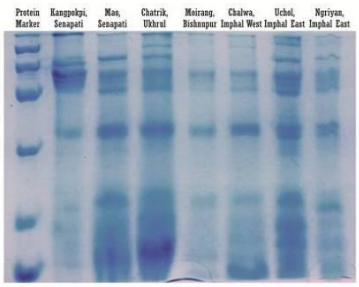


Fig 16 SDS-PAGE protein profile of tree bean genotype

SPICES

TURMERIC

Fig 17 RCMT-4

The experiment was undertaken to develop suitable varieties of turmeric for Manipur by clonal selection form potential indigenous germplasm. A total 26 advance breeding line of F_8 generations were evaluated based on different horticultural parameters. The accession RCMT-7 performed best (31.89 t/ha), followed by RCMT-4 (31.03 t/ha). Among the other clones, RCMT-14 (24.99 t/ha), RCMT-3 (24.35 t/ha) and RCMT-5 (24.10 t/ha) were also found promising. In terms of curcumin content RCMT-7 (8.5%), RCMT-23 (7.45%), RCMT-13 (7.35%) and RCMT-12 (7.10%) were found promising.

CHILLIS

Genetic diversity of king chilli landraces of Manipur using microsatellite marker

All total 22 king chilli landraces were collected from different parts of Manipur, including one from Nagaland. In addition, two commercial capsicum varieties (Thai Wonder and Yellow King) were included in the study. Thirty eight SSR primar were used for charcaterization of landraces. Chilli similarity ratio revealed that high degree of similarity to the extent of 88% exists between RCMKC-1 and -11, whereas very low level of similarity (65%) exists between Thai Wonder and Yellow King (*C. annuum*). Cluster analysis was used to group the genotypes and to construct a dendogram. A total of nine distinct groups (Fig 15) resulted out of analysis of pooled SSR marker data. The dendogram revealed that the genotypes that are derivatives of genetically similar type clustered more together. The result of principle component analysis was similar to UPGMS analysis. The Manipur landraces were found to be different from Nagaland genotype included in the study. The Nagaland Local has similarity with RCMKC-7 and -9. Both the landraces were collected from Ukhrul district . Among the Manipur genotypes, RCMKC-7 was found to be different from rest of the group. The landraces collected from Chatrik village of Ukhrul and Thingkeu village of Churachandpur were also found to be different from other Manipur landraces.

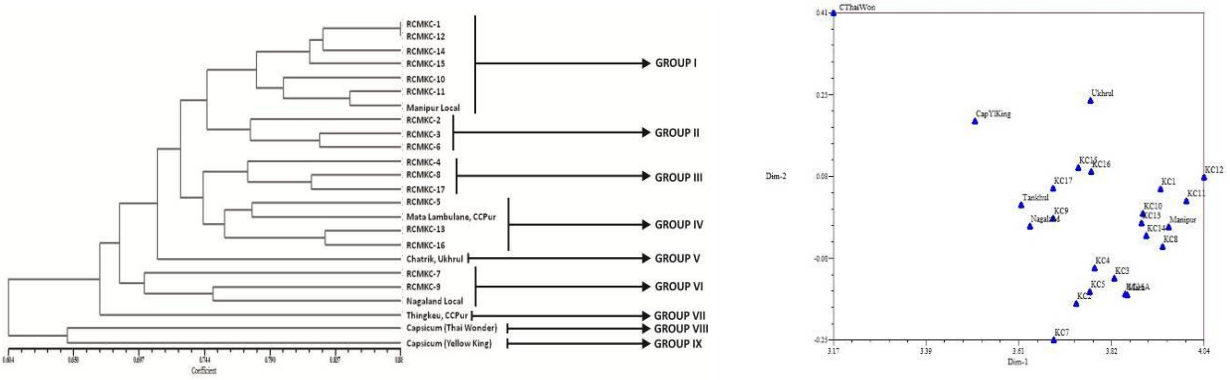
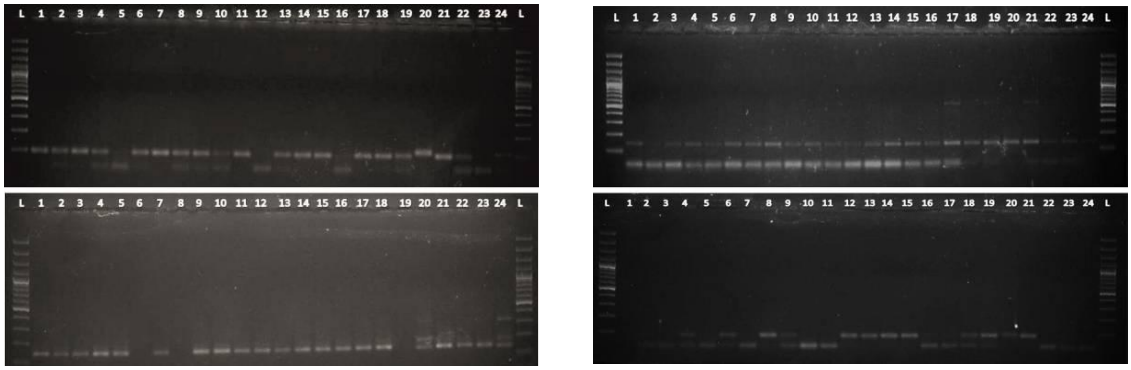


Fig 18 Dendrogram showing diversity of King chilli genotypes



L: 100bp DNA Ladder, Lane No 1: RCMKC-1, Lane No 2: RCMKC-2, Lane No 3: RCMKC-3, Lane No 4: RCMKC-4, Lane No 5: RCMKC-5, Lane No 6: RCMKC-6, Lane No 7: RCMKC-7, Lane No 8: RCMKC-8, Lane No 9: RCMKC-9, Lane No 10: RCMKC-10, Lane No 11: RCMKC-11, Lane No 12: RCMKC-12, Lane No 13: RCMKC-13, Lane No 14: RCMKC-14, Lane No 15: RCMKC-15, Lane No 16:RCMKC-16, Lane No 17: RCMKC-17, Lane No 18: Manipur Local, Lane No 19: Nagaland Local, Lane No 20: Capsicum Thai Wonder, Lane No 21: Chatrik village (Ukhrul), Lane No 22: Thingkeu Village (CCPur), Lane No 23: Mata Lambulane (CCPur), Lane No 24: Capsicum Yellow King.

DISEASES

Studies on diseases of King Chilli (*Capsicum chinense*) and their management

The survey was carried out in localities around Imphal to assess the incidence of different fungal and viral diseases. The fungi isolated and identified from king chilli are *Cercospora capsici*, *Colletotrichum capsici*, *Glomerella cingulata*, *Corynespora cassicola*, *Phoma destructive*. There is sporadic occurrence of virus diseases in the field. The symptoms consisted of inward rolling of leaves, shoestring, yellow mosaic and necrotic rings on leaves. To find out the seed borne nature of the viruses, the seed was extracted from virus infected plants. The seed were sown under insect proof net to observe the expression of symptoms on newly emerged leaves. Out of the 2000 plants observed in the nursery, none showed expression of symptoms, thereby indicating that the viruses are not transmitted through seed. The virus inducing shoe stringing symptoms was successfully transmitted to 7 healthy plants of king chilli and there was shoe stringing of king chilli leaves. The plants showing different symptoms were tested using polyclonal antisera against *Potato virus Y* (PVY), *Cucumber mosaic virus* (CMV) and *Bean common mosaic virus* (BCMV). Bean common mosaic virus has not been reported from chilli. On the basis of comparison of the absorbance readings of

the negative controls (healthy samples) with the absorbance readings the samples, none of the plants were infected with either *Potato virus Y* or *Cucumber mosaic virus* or *Bean common mosaic virus*. The samples from plants exhibiting different symptoms were thin sectioned and analyzed with transmission electron microscope at North Eastern Hill University, Shillong. In all 102 micrographs were taken. The careful analysis of the photographs did not reveal the presence of virus particles or inclusion bodies. The crude virus extract of different virus infected kingchilli samples was also subjected to Transmission Electron Microscopy and it revealed the presence of flexuous virus particles which means that the virus belonged to genus *Potyvirus* of family Potyviridae.

POST HARVEST TECHNOLOGY

Evaluation of the stability of *sohiong* squash

The study was carried out to ascertain the effect of different temperature and storage conditions on the stability of squash of *Prunus nepalensis* (an important indigenous fruit of Manipur and Meghalaya). Squash was prepared as per the FPO specification. The storage conditions were 0^0C Day Light (T_1), 35^0C Day Light (T_2), 0^0C Dark Light (T_3), 25^0C Dark Light (T_4) and 35^0C Dark Light (T_5). Observation on TSS, total sugar, titratable acidity, pH and total anthocyanin content was recorded at one month interval for 3 months. There was a slight increased in the TSS, total sugar and pH was observed during the different storage conditions and storage interval. On the contrary, the titratable acidity showed a slight decrease during the different storage conditions and storage interval in squash. Although, statistically no significant differences were observed in the studied parameters as the variation was too narrow that almost a constant TSS, total sugar, titratable acidity and pH was observed during the experimentation period.

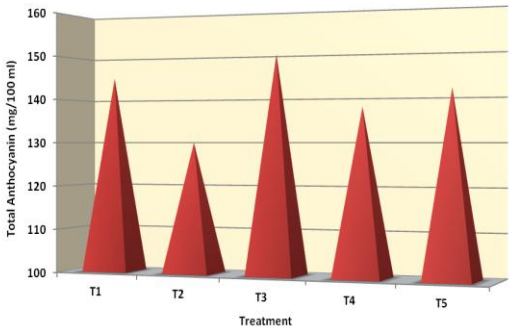


Fig 19 Changes in total anthocyanin content of *sohiong* squash

However, significant change was observed in total anthocyanin content with respect to different temperature and storage conditions as well as duration of storage, where 0^0C Dark retains the maximum anthocyanin (150 mg/100 ml) and 35^0C Day retains the least anthocyanin content (130 mg/100 ml). The changes might have occurred due to degradation

and polymerization of red pigments or due to effect of fructose produced by the hydrolysis of sucrose. The least change in the TSS, acidity, pH and total sugar of the squash during storage reflected that the product was stable and there is no biochemical and microbial spoilage

Value Addition in underutilized horticultural crops

The recipe for different value added products (Figs 17-20) were standardised. The list of the products developed were as given below

Citrus jambhirri	:	Juice, Ready to serve, Squash, Sweet pickle, Hot pickle
Passiflora edulis	:	Juice, Ready to serve, Squash, Ice cream, Powder
Averrhoa carambola	:	Squash, RTS, Blended juice with passion fruit
Prunus nepalensis	:	Squash, Ready to serve, Jam, Powder
Elaeagnus umbellata	:	Squash, RTS, Blended juice with passion fruit
Emblica officinalis	:	Juice, Candy
Capsicum chinense	:	Pickle

In addition, spray drying technique for *Ananas comosus*, *Prunus nepalensis* and *Passiflora edulis* was standardized.

Fig 20 Spray dried powder from pineapple, *sohiong* & passion fruit

Fig 21 Passion fruit flavoured ice cream

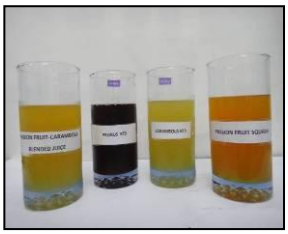


Fig 22 Value added products from passion fruit, sohiong & carambola

Fig 23 Value added products from japanese silverberry

TECHNOLOGY MISSION (MM I)

Horticulture based cropping system for livelihood improvement of hill farmers in Manipur

The block of banana (Grand Naine), orange (*Khasi* mandarin), lemon (Kachai Lemon), passion fruit (Kaveri) and pineapple (Kew) were developed. The orange, lemon and passion fruit plantations are still at vegetative stage. Banana var. Grand Naine and pineapple var. Kew showed a potential yield of 42.50 t/ha and 45.66 t/ha, resp. The standardization of suitable intercrops under horticulture based cropping system was done. In the first experiment, cucumber var. Tohfa-786 was evaluated with four different trellis system *viz.*,

bower system, espalier system, single wire system and telephone system. In terms of yield and number of fruits per vine, espalier (kniffin) system of trellis was found most suitable for cucumber in paddy fallow of Manipur valley. The different combination of organic manures *viz*. FYM and vermicompost and microbial inoculants *viz.*, *Azospirillum*, *Bacillus* and AM (*Glomus fasciculatum*) were tried for the organic production of turmeric cv. Megha Turmeric-1. Among them application of Vermicompost (5 t/ha) + *Azospirillum* (10 kg/ha) + *Bacillus* (20 kg/ha) + AM (65 kg/ha) was found most effective in terms of yield (25.33 t/ha) and curcumin content (6.8%). Another experiment was undertaken to standardize the nitrogen dose for maximizing the yield of amaranth (local cultivar) under horticulture based farming system. The maximum plant height (44.92 cm) and leaf yield (8.13 t/ha) was recorded in 100:60:60 NPK kg/ha.

Protected cultivation package for watermelon

The experiment was undertaken to standardize the low-cost protected cultivation package for watermelon to avoid frost injury and shorten the gestation period. Hybrid varieties *viz.*, Namdhari and H-20 were transplanted under low-cost poly tunnel and open field condition. The fertilizers were applied through fertigation and soil application. Irrigation was applied through drip method. The data revealed that, per cent increase of number of flowers/plant over control was found maximum (150.21%) with plants grown under poly-tunnel and soil application of fertilizers, followed by 45.21% with plants grown under poly-tunnel and fertigation. With respect to number of fruits per plant, maximum per cent increase over control (135.00%) was recorded with plants grown under poly-tunnel and soil application of fertilizers, followed by 76.67% with plants grown under poly-tunnel and fertigation. Maximum yield (35.5 t/ha) was recorded with poly tunnel and soil application of fertilizers, followed by poly tunnel and fertigation (28.2 t/ha) and control plots (15 t/ha). The results indicated that the gestation period can be shorten by one month by using low cost poly tunnel as compared to open field condition.

Standardization of life-saving irrigation technology for different horticultural crops

Water is the scarcest commodity in Manipur during winter season. In this backdrop, the present experiment on low cost drip irrigation in cauliflower var. White Flash was undertaken. The crop was irrigated for 2 hours daily and at an interval of 2 days, 3 days and 4 days. Maximum curd formation was recorded with irrigation at 3 days interval. Maximum yield (16.9 t/ha) was observed with daily irrigation, followed by irrigation at 2 days interval

(16.2 t/ha), but the difference is statistically insignificant. Therefore, drip irrigation for 2 hours at two days intervals can be recommended for cauliflower under Manipur valley. Another experiment has been undertaken to standardize the micro-irrigation requirement of cucumber var. Alamgir CT-380. The crop was irrigated daily and 2, 3, 4, 5 and 6 days interval through low cost drip irrigation. Need based irrigation was included as control. Espalier system of trellising was followed for the crop. The experimental results revealed that, drip irrigation for 2 hours at 2 days interval recorded maximum yield (29.7 t/ha) of cucumber as compared to 8.5t/ha in control, indicating a great scope for large scale cultivation of cucumber as paddy fallow.

Table 3 Transfer of technology under Technology Mission (MM-1)

Topic of the Training/Demonstration	Number
Improved Production and Rejuvenation Package for *Khasi* Mandarin, Kachai Lemon and Large winged Orange (Heiribob)	8
Improved Production Technology of Passion fruit	1
Scientific Production Technology for Vegetables	4
Technology for Seed Tuber Production (TPS)	1
Mushroom Production Technology	2
Improved Production Package of Turmeric and Ginger	2
Value Addition of Fruits and Vegetables	4
Farmers' Field Day on Cabbage	1

NATIONAL NETWORK ON INTEGRATED DEVELOPMENT OF JATROPHA

Under the R&D programme, local exploration was conducted for collection of local

Fig 24 Citrus rejuvenation programme

Fig 25 Rejuvenation programme on kachai lemon

Fig 26 Training on passion fruit processing

Fig 27 Community based value addition of king chilli

Fig 28 Demonstration on off-season vegetables farming

Fig 29 Demonstration on early cauliflower

genotypes of jatropha in Manipur. All total 21 local germplasm (MNJ-001 to MNJ-021) were collected, out of which, three accessions (MNJ-001, MNJ-006 and MNJ-017) were found promising oil content (> 40%). The results indicated a large scope for exploitation of superior accessions of Manipur for further improvement. Besides, kernel characteristics of 14 local genotypes and fatty acid profiling of 12 accessions were done. Different trials *viz.*, Progeny Trial, Zonal Trial, Multi locational Trial, National Trial I, National Trial III and Local Trial were conducted and promising accessions were identified.

Table 4 List of trials on jatropha

Name of the trial	Year of planting	Number of genotype	Promising genotype(s)
Progeny Trial	July, 2006	13	MNJ-002, TFR-01 and JIP-13
Zonal Trial	August, 2006	6	JIP-13
Multilocational Trial	July, 2007	10	Plants are still at vegetative stage
National Trial I	August, 2006	6	TFRI-01
National Trial III	August, 2008	7	Plants are still at vegetative stage
Local Trial	August, 2006	16	MNJ-001, MNJ-002 and MNJ-006

In addition, research was undertaken to standardize the package of practices for jatropha under Manipur condition. Under spacing trial, the maximum fruit yield and seed yield for both MNJ-002 (1010 g/plant & 600.00 g/plant respectively) and MNJ-005 (748 g/plant & 479 g/plant respectively) was recorded with plants spaced at 3 m X 3 m. However, due to higher population, plants spaced at 2 m X 3 m distance produced maximum fruit as well as seed yield in both MNJ-001 (1411.67 kg/ha & 825 kg/ha respectively) and MNJ-005 (1231.67 kg/ha and 801.67 kg/ha respectively). The plants under pruning trial and fertilizer trial are still at vegetative stage. However, pruning height of 90 cm was found to be the most suitable in terms of number of branches and collar diameter tested over 7 genotypes. In fertilizer trial, application of urea, SSP and MOP @ 150, 250 and 50 g/plant respectively resulted maximum number of branches was found with urea, SSP and MOP @ 100, 250 and 50 g/plant, respectively. Among the different intercrops evaluated, sweet potato (var. Gauri) was found to be the most suitable intercrops for jatropha under foothill condition of Manipur followed by Soybean (var. JS-335) and groundnut (var. ICGS-76). French bean (var. Anupam) also performed well.

CROPPING SYSTEM

Crop diversification for increasing agricultural productivity with moisture conservation practices in upland

A field experiment was conducted during *rabi* season in split plot design with combinations from five cropping systems (mustard sole, lathyrus sole, pea sole, , mustard + lathyrus, and mustard + pea) in main plots and moisture conservation practices (control, polythene mulch + groundnut straw mulch, paddy straw mulch and thatch grass mulch in sub-plots. The cropping system had significant effect on grain yield of mustard sole (0.73t/ha), Lathyrus sole (0.68 t/ha) and pea sole (1.99 t/ha) than their intercropping system. The significantly higher grain yields of mustard, lathyrus and pea were recorded when grown with plastic mulching + groundnut straw followed by thatch grass and straw mulching as compared to control (no mulching).

SEED TECHNOLOGY

Feasibility study on scientific production and storage of farmers' saved seed in major crops

In rice varieties RC Maniphou-7 and RC Maniphou-10, the off types could be reduced to 0.48% as compared to 20.83% and 8.93% respectively under farmers' conditions. The yield advantage due to seed quality was as high as 22.65% over those using locally saved seeds. In maize too the purity of the variety could be maintained to certification standard. The maize variety Pusa Composite-3 seed produced with time isolation by *rabi* sowing in Thoubal and Imphal West district was maintained upto 7^{th} generation and purification (selection) to obtain certifying level quality saved seeds. In rapeseed , Sep to Oct sowing with zero tillage technique, isolation could avoid outcrossing. In M 27, rapeseed early sowing during Sep-Oct maintained the purity level within permissible limit under Indian Minimum Seed Certification Standards. Seeds stored under desiccated condition low cost RC Seed Bin maintained the minimum standards and seed health quality for more than two sowing seasons when compared to the ambient traditional storage (ambient) practice which maintained hardly for eight months. Seed moisture in RC-Seed Bin was maintained at 10.5% in rice, 10.7% in maize and 8.25% in rapeseed.

Maintenance breeding of locally released varieties of rice

Two varieties for pre *kharif viz*., RC Maniphou 4 and RC Maniphou-5 and four main *kharif* varieties *viz*., RC Maniphou-6, RC Maniphou-7, RC Maniphou-10 and RC Maniphou 11 were taken. In maize composite variety Pusa Composite 3 has been maintained since 2005 with time isolation by sowing during *rabi*. Rapeseed variety M 27 was maintained for 6 years with purity level through early sowing and selection. During the year, altogether 2719 kg basic and labelled seeds were produced. 1155 kg RC Maniphou-4 and 1680 kg of RC Maniphou-5 were produced as pre *kharif* varieties. 3770 kg of basic seeds of RC Maniphou-7, 900 kg of RC Maniphou-10 were produced. Seeds of RC Maniphou-6(90 kg) and newly released RC Maniphou 11(390 kg) were under nucleus seed stock production through panicle row selection. In addition, 7944 labelled seed of different rice varieties were produced. In maize, 60 kg of basic seed of Pusa Composite-3 was produced. In rapeseed (M27) , pure seed was maintained by early sowing and 80 kg of breeder quality seed and 590 kg foundation seed was produced. In groundnut, variety ICGS 76 (210 kg seed) and in soybean, varieties JS 335 (250 kg) were maintained. In addition to this, 300 local rice germplasm are also maintained.

Development of seed storage practice: use of botanicals in seed storage

In an to develop sustainable low cost medium seed storage technology for different effort crops, studies were conducted in major crops *viz*., rice, maize, soybean, rapeseed and pea. The effect of botanicals in seed storage was assessed. There was reduction in storage pests with application of locally available botanicals viz., *Artemisia parviflora*, *Goniothalamus sesquidedalis*, *Plectranthus ternifolius* and *Vitex negundo*. These botanicals, when applied to the storage pests exhibited knock down effects showing repellent action but no lethality of the insects. Efficacy period of the plants tested was hardly a few weeks (5-12 days). Seed viability too declined beyond the permissible limit after the second sowing season. However, storage of treated seeds with powders of the above plants under desiccated conditions through charcoal could reduce the moisture and thereby the infestation of macro and micro organisms

Fig 30 Grow out test of farmers' own rice see

Fig 31 Own maize seed production by a farmer with time isolation (*rabi* sowing)

too. Desiccated conditions could maintain seed quality up to two sowing seasons and retain the mycloflora at negligible level (0 after 8-20 months). Among the four plant species, *Plectranthus ternifloius* (26.5) was found to be most effective in reducing the seed micoflora against control 34.3.

Development of seed production packages in important crops

For self pollinated crops like rice peas, legumes, not much problem were noticed if some recommended standard are adopted for seed source, site selection, roguing, handling and storage. In outcrossed crops like maize, rapeseed and mustard, time isolation were more practicable than the distance isolation. For maize (open pollinated varieties), time isolation by *rabi* planting (Oct-Jan) was found suitable both for pollination and post harvest operations. Early planting (Aug to Oct depending on soil moisture) was suitable for rapeseed, M 27 in the uplands. For this variety, seed produced under zero tillage practice was also suitable for time management (early sowing) besides maintaining the high seed quality level. Seed production studies in wetland rice found that the spacing of 20cm × 10cm with a gap of 0.5 m after every 1.5m gave better seed yield of 3.7 t/ha. In pre-*kharif*, yield of RC Maniphou 6 was 3.5 t/ha, RC Maniphou 4 (3.34 t/ha), RC Maniphou 5 (3.10 t/ha). In *khari*f varieties, higher yields of RC Maniphou 7 (3.77 t/ha), RC Maniphou 10 (4.62 t/ha) and RC Maniphou 11 (3.77 t/ha) were also recorded. In maize good seed under *rabi* (Jan) sowing was obtained as intercrop with field pea. In rapeseed, the sowing in the valley and in the hill gave a yield of 0.5 t/ha. Spacing of 40cm × 30cm was found better in soybean (JS 335) over closer spacing. In groundnut, early sowing during first pre-monsoon (Apr-May) was favourable to escape leaf spot disease for better seed health. Earlier than May sowing of soybean gave poor seed set and yield as well as seed health due to rust infection.

NICRA

CROP SCIENCE

Survey, collection and screening of cold and drought tolerant rice germplasm

Five rice varieties *viz*., Leimaphou, RC Maniphou-7, RC Maniphou-10, CAUR-1 and RC Maniphou-11 were screened for cold tolerance by late sowing on different dates) i.e, 3rd and 22nd August, 2011. In early sown condition, RC Maniphou-10 gave better seed set percentage of 55.55 % followed by RC Maniphou-7 (30.27 %). Again in late sown conditions, RC Maniphou-7 (8.03 %) had better seed set percentage than other varieties. The

maximum temperature ranged from 22.3 to 32.6 ^{0}C and minimum temperature ranged from 6.9 to 18.5 ^{0}C during the flowering stage in the first sowing. For the second sowing, maximum temperature ranged from 20.9 to 28.7 ^{0}C and minimum temperature range from 1.9 to 11.6 ^{0}C during the flowering stage. The performance of the varieties declined with lowering of the temperature.

Study on effect of submergence on growth and yield of rice

Submergence tolerance study of rice was carried out on five varieties. The varieties were RC Maniphou 6 (RCM 5), RC Maniphou 4 (RCM 7), RC Maniphou 7 (RCM 9), Taothabi (local floating rice) and Akutphou. Varieties with 60, 45, 30 and 20 days old seedlings were half submerged for 5, 10, 15 days and full submergence for 5, 10, 15 days. Among the varieties 60 days old seedlings of Taothabi had the highest plant height of 114.33 cm in 15 days under half submergence followed by Akutphou with 98.67 cm with 15 days half submergence. The highest grains/plant was found in the variety RC Maniphou 7 with 914.34 filled grains in 5 days half submergence followed by RC Maniphou 4 with 800 filled grains in 10 days half submergence of 60 days old seedling. Seed set percentage was highest in 60 days old seedlings RC Maniphou 7 in 15 days half submergence followed by RC Maniphou-4 with 84.67 % 60 days old seedling. The weight of seed per panicle was highest in RC Maniphou 4 with 5.27 g followed by RC Maniphou 6 with 3.41 g half submerged for 10 days in 60 days old seedling. It was found that seedling with longer duration showed more good performance than the shorter duration seedling either submerged for half or full submergence.

Impact of climatic factors on production and productivity of tomato

For efficient crop planning and water management under the existing trend of global climate change, the trend analysis of daily average weather variables at Manipur Centre (24^{o}45'N, 93^{o}54'E, 774 m above MSL) using Mann-Kendall test and Sen's slope method, showed varied annual trends. Increasing trend was observed for annual average of both T_{max} (0.0055^{o}C/day) and T_{min} (0.0244^{o}C/day); whereas, annual average of T_{max} and T_{min} was 26.63^{o}C/day and 14.51^{o}C/day respectively. In case of annual rainfall, no. of rainy days and annual average of relative humidity, increasing trend was observed (3.04 mm/year, 0.071 days/year and 0.166%/day, respectively). The normal annual rainfall was found to be 1430.7 mm; whereas, the average number of rainy days was found to be 97.00 days/year. The annual average of RH_{Mean} was found to be 75.09%/day. However, the coefficient of variation w.r.t. distribution of rainy days was found to be 12.11%, indicating that the pattern is not irratic

(CV≤20%). The results revealed that there is an increasing trend in the temperature, emphasizing to develop varieties with crop diversification to withstand the heat and cold tolerance simultaneously.

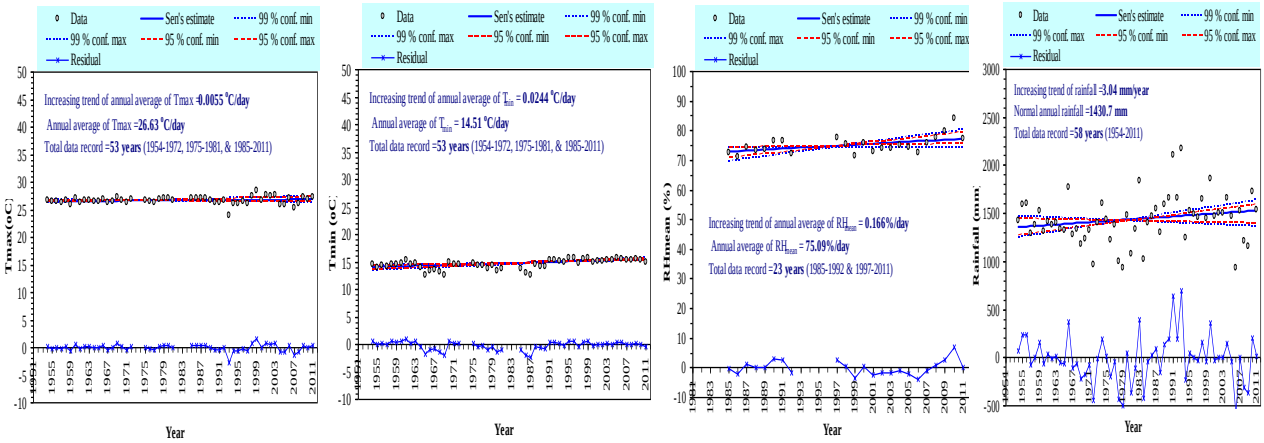


Fig 32 Trend analysis of daily average weather variables at Manipur Centre

In this backdrop, five tomato genotype collected from IIVR, Varanasi and five breeding lines developed by ICAR-RC-NEH, Manipur Centre were tested under three growing conditions *viz*., natural field condition (exposure to frost), low-cost poly house condition (exposure to heat) and 50% agro shade net condition (exposure to low light intensity). Irrespective of genotypes, maximum plant height (32.86 cm) and maximum no. of secondary branches per plant (7.50) were recorded in the plants grown under agro-shade net condition; whereas, maximum chlorophyll concentration (25.96 CCI) was associated with open field condition. Plants grown under low cost poly-house showed maximum no. of primary branches per plant (5.73) and minimum days to 50% flowering (34.30 days). Irrespective of growing condition, maximum plant height (36.97 cm) and maximum chlorophyll concentration (33.64 CCI) were recorded with Kashi 2124; whereas, maximum number of primary branches (7.56) and secondary branches (8.11) per plant was observed in Selection 11 and Kashi Hemant, respectively. Shortest duration required for 50% flowering (44.11 days) was associated with Selection 9A. Based on days required for 50% flowering, Kashi Anupam (29.00 days) and Kashi Amrit (41.00 days) were found to be promising under low cost poly-house; whereas, no significant difference was observed between the varieties grown under agro-shade net. Maximum chlorophyll content in leaves

Fig 33 Tomato Genotypes under 50% Agro-shade Net Condition

was recorded with Kashi 2124 irrespective of growing condition (26.77 CCI, 33.51 CCI and 40.63 CCI under low cost poly-house, agro shade net and open field condition, respectively). Irrespective of varieties, minimum duration to first fruit maturity (61.40 days) was recorded under low-cost poly house condition, followed by 62.50 and 66.50 days under 50% agro-shade net and open field condition respectively. Irrespective of growing conditions, Kashi Amrit showed early maturing character (58.67 days) as compared to longest duration (71.67 days) in Manileima. Similar trend has been observed with respect to days required for first fruit harvest. Irrespective of varieties, first fruit was harvested within 64.10 days from the plants grown under low-cost poly house, followed by 66.70 and 69.30 days under 50% agro-shade net and open field condition, respectively. Irrespective of growing conditions, minimum days required for first fruit harvesting (61.67 days) was found in Kashi Amrit followed by Manikhamnu (62.67days), whereas, maximum duration (75.33 days) was associated with Manileima. The crop under experimentation is now at bearing stage; hence, a significant conclusion can be drawn only after harvesting of the crop.

Impact of weather parameter on population build up of aphids on cruciferous crops

In mustard, aphid population showed its presence throughout cropping season. During vegetative stage aphids were observed on leaves and with the onset of reproductive phase the population shifted from foliage to inflorescence. From last week of Oct population started increasing and reached to its peak level in the first week of December (4-10 Dec) when mean maximum and minimum temperature, morning and evening relative humidity, wind velocity, morning and evening cloud cover, sunshine hrs and rainfall were 25.0°C and 8.8°C, 87.71and 55.57%, 2.2 km/hr, 6 and 4 okta, 5.96 and 0.0. The correlation between aphid population and climatic factors in mustard showed no relationship with weather parameters.

Table 4 weather parameters in relation to aphids population

Aphid population	Temperature (°C)		Relative humidity (%)		Wind Direc-tion (Deg.)		Wind Speed (km/hr)	CC (Okta)		Rainfall (mm)	Sunshine (hrs)
	Max	Min	700 h	1300 h	700 h	1300 h		700 h	1300 h		
Mustard	-0.21	-0.37	0.11	0.11	-0.03	-0.16	-0.35	0.40	0.25	-0.34	-0.42
Cabbage	0.58	0.62	0.0	-0.07	-	0.16	0.62*	-	0.30	0.13	0.16

	*	*	3		0.38			0.17			
Cauliflower	0.68*	0.63*	-0.15	-0.17	-0.39	0.21	0.73*	-0.20	0.09	0.37	0.22
Broccoli	0.59*	0.67*	0.08	-0.03	-0.37	0.11	0.59*	-0.10	0.30	0.27	0.13

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

In cole crops, aphid appeared in the last week of December (25-31 Dec) with a average population of 1.34, 0.68 and 0.8 on cabbage, cauliflower and broccoli, respectively, The peak level of aphid infestation (average population 362.56, 224.56 and 157.7 on cabbage, cauliflower and broccoli, respectively) was attained in 3rd week of March (11-17 March) when mean maximum and minimum temperature, morning and evening relative humidity, wind velocity, morning and evening cloud cover, sun shine hrs and rainfall were 27.81 and 10.83°C, 82.29 and 41.0%,7.04 km/hr, 3.43 and 4.57,7.54 and 0.00. Aphid population in cabbage, cauliflower and broccoli was positively and significantly correlated with a temperature and wind speed. Major insect pests observed were same on cabbage, cauliflower and brocolli.

Cabbage butterflies (*Pieris brasssica* and *P. candida*) infested more on cabbage than cauliflower and broccoli. Aphid (*Brevicorryne brassicae, Lipaphis erysimi*), Diamond back moth (*Plutella xylostella*), Cabbage green semilooper (*Trichoplusia ni*) were also recorded. In mustard, saw fly (*Athalia lugens proxima*), cabbage butter flies (*Pieris brassicae* and *Pieris canidia*), pea pod borer (*Lampides boeticus*), and Bihar hairy caterpillar were major pests recorded on mustard.

ANIMAL SCIENCE

Induced breeding of *Bangana dero* in extended breeding season

Bangana dero is an indigenous minor carp of Manipur. It is a seasonal spawner that spawns only in river during June-July. An attempt was made to breed the fish in mid September i.e., beyond normal breeding season by induced breeding using synthetic hormone Wova FH at different doses. Two doses of Wova FH @ 0.5/kg and 0.6/kg were tested. Three sets of

spawners of each dose at the ratio of 1:1 were selected for the induced breeding experiment. The selected doses were injected on the dorsal muscle above the lateral line. After the injection, the brooders were released in circular breeding and 6-7 hours after injection, the fish showed responses of behavioural changes and released eggs. Fertilized eggs were hatched out between 24-48 hrs after fertilization. The fertilized eggs underwent development and young hatched larvae measured 4.2 mm long and 1.5mg in weight. They did not take exogenous food for about 72 hours at 25°C. The yolk sac was fully absorbed on the 4th day and the hatchlings grew to 5.5-6.0 mm.

Suitable larval rearing and grow out culture techniques of *Clarias magur*

Clarias batrachus now known as *Clarias magur*, commonly known as Ngakra in Manipur. The aim of the present study was to find out suitable larval rearing and grow out culture techniques. Highest growth rate (0.053/day), percentage growth rate (131.6%), specific growth rate (59.78) and survival rate (84.2%) of *C. magur* was obtained in fish stocked in a pond having 0.80 cm water depth.

Performance of CB piglets (Hampshire & Yorkshire) and Vanaraja birds

Performance of 15 CB piglets distributed among beneficiaries of Imphal west (4) and Tamenglong (3) was assessed. Growth rate was better in valley of Imphal West district, this indicated better availability of food resource from various source and provided better nutrition. Average daily weight gain in Hampshire CB male was 13 g/day at 3 to 4 month and in female 4 g/day. In HSR X YSR ,51g/day in male and in female 12 g/day. The piglets were vaccinated against Hog cholera and FMD. De-worming for internal parasite was accomplished with Piperazine liquid and Albendazole. There was no mortality up to 4 month. The overall morbidity recorded was 55% and major clinical conditions recorded were anorexia (55%), diarrhoea (15%) and skin disease (5%). Cocidiosis and ascariasis were common among the piglets. In poultry, Vanaraja birds under semi-confinement system of rearing attained body weight (g) of 906.07, 1516.03 and 2906.87 at 10, 16 and 40 wks, respectively. Age at sexual maturity was 162-175 days. Marketing age reached at 12- 15 wks.

Standardization of Seed Production and Culture Techniques of Some Potential Indigenous Fish Species of Manipur for Aquaculture

Bangana dero

Bangana dero fries having 0.85±0.1g weight and 5.1±0.1cm length were stocked in 3 different earthen ponds having 88 sqm in different stocking densities i.e 65, 88 and 132 fishes @ 8,000/ha, 10,000/ha 15,000/ha respectively. Fishes were fed with a pelleted feed having 30% CP @ 5% body weight per day. Fish samples were weighed at every 10 days intervals and feeding rate was adjusted according to the new body weight record. The growth rate in all

Fig 34 *Bangana dero*

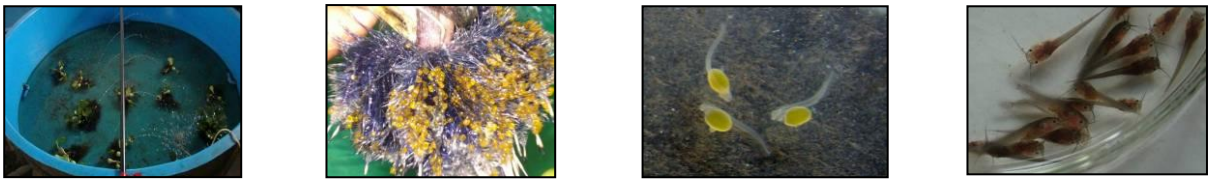


Fig 35 Breeding and hatching of *Clarias magur*

treatment was found to be high and there was no significant difference in the growth rate. The highest growth rate was found in fish stocked @10,000/ha. The survival rate also obtained in all different stocking densities was high. The rate was found over 80%.

Clarias magur

The study attempt to develop simple techniques for breeding and hatching of *Clarias magur*. The female broods of 120-140 g weight range were selected for induced breeding. Wova-FH was used as hormone for induced breeding of fish. Injections were administered @ 8ml/kg body weight of the fish intramuscularly, in the dorso-lateral region of the female body. The sperms were pooled and diluted with 3 ml of physiological saline to prepare a sperm suspension. At the end of the desired latency period of 19h, the females were stripped individually into dry and pre-weighed petri plates to record the stripped egg weight. Three subsamples of each 250-300 mg egg were weighed and mixed with 4-5 drops of sperm suspension. After thorough washing with water, they were released into the round Fibreglass tub of 250 l capacity provided with flow-through water system for 2-3 min and shower to increased dissolved oxygen. 10-15 fresh and cleaned water hyacinths were suspended in tubs

as a substrate to hatch the eggs. 9-92% hatching were obtained. After 3 days of hatching first feeding is given. Live zooplankton is used as food up to satiation level. Fry remain into the cistern for 2 days then they are transferred into the nursery pond.

Standardization of breeding and culture techniques for indigenous ornamental fishes of Manipur ➡ ➡ ➡

15 indigenous ornamental fish species were collected from the waters of Imphal valley, Lokchao river, Chandel District, Izei river, Tamenglong District and hill streams of Senapati district. The fishes were maintained in laboratory for further studies.

Table 5 Food and Feeding Habit, Size, Sexual Differentiation and Breeding Behaviour of the Selected Fishes

Scientific Name	Habitat	Water Quality	Food and Feeding Habit	Reproductive Biology
Mystus ngasep	Size 15.7cm Bottom feeder, inhabit swampy lakes, ponds, ditches of Imphal valley	pH- 5.8-7.5; Temp 18-25°C Dissolved Oxygen 4-8ppm	Omnivorous, feeds on worms, insects, crustaceans, algae	Males have an elongate genital papilla in front of the anal fin.
Parambasis waikhomi	Rivers and lakes of Imphal valley, Size	pH 5.2-7.5 Temp. 24-26°C Dissolved Oxygen 5-8ppm	They feed primarily on small live foods, such as crustaceans, insect larvae and worms	Young male and female fish are very similar, but when mature, males tend to have slightly larger dorsal and anal fins, which are edged in gray. Female fish, which have less-colorful fins than males
Lepidocephalus irrorata	*L. irrorata* is a demersal bottom feeder, which inhabits flowing water.	pH 5.2-7.5 Temp. 24-26°C Dissolved Oxygen 3-6ppm	Feed on worms, insects eggs and larvae, detritus	Females are larger. Males are dark and pinkish anal fin during breeding season

Fig 36 Mystus ngasep

Fig 37 Lepidocephalus irrorata

Fig 38 Parambasis waikhomi

Fig 39 Botia dario

Devario acuticephala Bred in Laboratory

Devario acuticephala is an endemic fish occur in hill streams, paddy field of Senapati and Ukhrul districts of Manipur at about 800 m AMSL. This species is likely to be restricted to small hill streams with substrates of gravel/variably-sized rocks and some marginal or over-hanging vegetation. Thirty fish fries having 20-22 mm were collected from Litan area of Ukhrul district in May 2010 were stocked in a rectangular fibreglass tanks having 80 litres of water capacity. The fishes reached 35-40 mm in 3 months rearing and matured. During culture period, the fishes were fed thrice with zooplankton, freeze-dried tubifex worm and artificial diet. Physico-chemical characteristics of water such as pH, water temperature, dissolved oxygen, total alkalinity and free carbon dioxide were monitored every two days intervals and maintained at 7.0-7.5, 24±2°C.

POULTRY

Mega Poultry Seed Project

Under the project, a total of 15,184 DOC and 643 grown up chicks (4 -5 wks. old) were provided in small numbers to 633 farmers (@ 25 birds per family) of nine districts of Manipur.

Performance of Parent Stock (Vanaraja & Gramapriya) under Farm Condition

A. Body Weight

The body weight at different ages at Institute's farm was higher than those of farmer's fields.

(i) Day old to 6th week of age

The growth of chicks in terms of body weight at weekly interval up to 6th week of age for Institute farm has been studied. The difference in Day old body weight (average) between

genetic groups / strains might be due to difference in size and weight of the eggs /strains. Lower body weights were found in Gramapriya chicks at all stages.

(ii) Between 7th and 8th week of age

The average body weight of chicks both in *Vanaraja* and *Gramapriya* strains in intensive system of rearing exceeded the averages of other rearing systems by 78 g & 67g respectively.

(iii) Between 9th and 20th week and at 40 weeks of age

An average daily weight gain of 99.67g was recorded in *Vanaraja* strain while 53.31 g in *Gramapriya*. The average body weights for *Vanaraja* and *Gramapriya* at 12th 16th and 20th week of age recorded under DLS was 1236.57 g, 1647.17 g & 2035.90 g and 809.87 g, 1014.70 g & 1458.56 g respectively. Vanaraja attained a body weight of 2892.26 g and 2204.23 g in Gramapriya strain at 40 wks of age.

B. Age at Sexual Maturity (ASM) and Egg production up to 40 and 72 Weeks

The ASM ranged from 164 to 171 days (averaged 166 days) in *Vanaraja* and 155 - 164 days (averaged 161 days) in Gramapriya strain. The egg weight at 24 and 40 week were 45.73 g and 52.18 g for *Vanaraja* and 46.19 g and 53.27 g for *Gramapriya* strain. The egg production of *Vanaraja* and *Gramapriya* by 40 and 72 wks of age was recorded at 47 and 133 eggs and 53 and 165 eggs respectively. *Vanaraja* and *Gramapriya* strain reached 50 % production by 198 and 190 days respectively. They have a moderate percent livability of 73.58 and 68.24 respectively. The fertility percentages for *Vanaraja* and *Gramapriya* were 83.68 & *87.40* respectively and the per cent Hatchability was 79.53 and 83.27 respectively.

Performance of Vanaraja and Gramapriya in the Backyards

The *Vanaraja* and *Gramapriya* strain produced in the institute were reared under backyard free-range conditions in the nine districts of Manipur as well as in two districts of Mizoram, one each in Assam and Nagaland states. The cross named "*Vanaraja"* attains average body weight (g) at 16, 24 and 40 weeks of age were 1563.91, 2429.20 & 2706.53 under semi intensive system while 1382.61, 2073.20 & 2391.46 were recorded in the open range management respectively, with a mortality of less than 4 % at the farmer's level. The *Gramapriya*, attains an average body weight (g) of 1283.07, 1675.61 & 2148.32 at 16, 24 and 40 weeks of age under semi intensive system while 1233.52, 1601.65 & 2193.30 respectively in the open range management with a production of 41 eggs by 40 wks of age. They attained sexual maturity at 166 days reached 50% production by 205 days and have recommendable livability records of 83.73 %. The mortality per cent was less than 5% indicating low rate mortality in the farmer's level. The per cent fertility and hatchability on total egg set of Vanaraja & Gramapriya were 72.89, 65.56 & 76.34, 68.61 and attained sexual maturity at 169 & 166 days

respectively. The egg weight (g) at 24 and 40 wks and egg production (nos.) up to 40 and 72 wks of Vanaraja & Gramapriya were 40.15, 51.0, 42.13, 51.19, 44, 49, 121 & 153, respectively. The above moderate level of production from the backyard was achieved by feeding household wastes, agricultural by products with supplementation of locally available tender leaves of weeds & grasses, calcium source powders, field snails etc. The Vanaraja and Gramapriya strain laid eggs weighing about 17g heavier than the indigenous chicken. Vanaraja bird weighed about 1.92 kg more than local chicken.

AGRICULTURAL EXTENSION

Role of mass media in farm technology dissemination among the farmers of Manipur

The mass media All India Radio (AIR), Doordarshan Kendra (DDK), Sangai Express and Poknapam are taken for analysis. The January to June 2011 is the period taken for analysis. The secondary data reveals that there are 123 agricultural topics narrow casted in DDK. Where as in case of AIR 22 agricultural programmes are broadcasted. Both All India Radio and Doordarshan Kendra (DDK) Imparts awareness and knowledge of the agricultural programmes. Whereas in Sangai express the 20 per cent of the agriculture programmes creates knowledge and 80 percent are of awareness creation only. Similarly 95 per cent of agricultural programme in Poknapam is of awareness generation only. The awareness generation here meant awareness on training programme, workshop, seminar, reports of field day, farmers fair, exhibition are generally reported. Further, the Doordarshan Kendra (DDK) and All India Radio (AIR) create knowledge on agriculture and allied activities. In the DDK the agriculture programme covers, horticulture (39.5%), field crops (29.5%), animal husbandry (13%), plant protection (6%), reports and viewers' letter (7.5%). In case of AIR, the agriculture programme covers, field crops (31.8%) followed by plant protection (27.2%), horticulture (22.7%) and social science (18.1%). There is no programme observed on animal husbandry and allied activities in AIR. The live phone in agriculture programme is also broadcasted in AIR.

Trainees knowledge on soil and water conservation measures

The Pre-test results shows that 82 per cent of the respondents have low knowledge on soil and water conservation measures. This result was taken with care and the training module was prepared accordingly to the trainees. The post –test result shows that the 64 per cent of the trainees have medium knowledge and the 32 per cent of the trainees have high knowledge. The trainees are extension personnel and the knowledge gained would be useful

in transferring the technology related to soil and water conservation to the farmers of Manipur region.

Adoption of soil and water conservation measures

The analysis through PRA in Khongampat Mayai Leikai village reveals that 70 per cent of the farmers have adopted farm ponds. The farm ponds are of small size. The 90 per cent of the farmers opine that lifting of water from the farm ponds are done manually. The farm ponds are utilized for growing fishes for home consumption. This water from the farm ponds are also utilized for growing vegetables in kitchen gardening. The tillage and broad bed and furrow are practised by more than 50 per cent of the farmers. The catch pits in the farm is also made to conserve water and to recharge the ground water. Occasionally the mulching is practiced by banana leaf for establishment of the crop by 20 per cent of the farmers. None of the farmers practice agro forestry, green manuring, roof water harvesting and paddy cum fish culture in the village. This finding reveals that farmers have to be taught the basic soil and water conservation measure through KVKS and the state extension personnel's.

NAIP COMPONENT -III

Livelihood improvement and empowerment of rural poor through sustainable farming systems in north east india

During the *kharif* season, 2011-2012 the progamme "Quality saved seed production" was taken up in the four cluster villages *viz*. Noney, Reangkhong, Awangkhul and Tupul Charoi Chagotlong in rice, groundnut and soybean. The average yield of RC Maniphou-10 during the season ranged from 3.0 t/ha in Awangkhul village to 4.0 t/ha in Noney village as against the local check yield of 2.9 t/ha (Plate 8). The recorded yield of groundnut (var. ICGS-76) was 1.25 t/ha cultivated in 1 ha adopting 10 total no of farmers. Soybean gave a satisfactory yield of 1.87 t/ha. Though agriculture in the district was mono-cropped keeping the lands mostly fallow during the *rabi* season, zero tillage technique in rapeseed M 27 allows farmers to plant 15 days earlier than usual. Since the cost of land preparation is nill, it generated higher net income (Plate 9). During the year 2011-12, the cultivation of rapeseed M-27 under zero tillage was in 41 ha area in four villages of the cluster by 95 farm families. The yield performance in four villages ranged from 0.04 t/ha to 0.10 t/ha with a combined average yield of 0.29 t/ha. This year the programme was poor due to the lack of rainfall. Potato was also cultivated in a total area of 2.8 ha adopting 121 farm families in the cluster villages of Project sites. 78 farm families adopted pea cultivation in 3.1 ha area and crop performed poor under

minimum tillage practices in cluster villages. An area of 0.8 ha for cabbage cultivation *var.* Rareball was adopted by 14 farm families with an average yield of 10.36 t/ha. Likewise, tomato var. F1 Samrudhi cultivation in 0.8 ha area by 18 farm families showed that one farm family may gain a gross return of Rs.5000-6,900 depending on the cultivated operational area. In the model mini polyhouse established at 3 cluster villages with farm families, 150 nos of capsicum plants (var. California Wonder) and 150 nos. tomato plants (var. Nidhi) were planted. Tomato and capsicum gave yields of 80kg and 10-16kg/season with net incomes of Rs. 2400 and Rs. 1000 - 1600 respectively.

Fig 42 Seed production for rice (RC MANIPHOU-10)

Fig 43 Zero tillage cultivation of rapeseed (M-27)

TRIBAL SUB-PLAN (TSP)

A. Jhum improvement through agro-forestry, horticulture, livestock and fisheries intervention in Manipur

The programme has been implemented in five hill districts (Tribal province) of Manipur *viz.*, Chandel, Churachandpur, Senapati, Ukhrul and Tamenglong. The project area comprises hilly slopes, narrow valleys and terraced land containing a wide range of microclimate (tropical to sub-temperate). The majority of the farmers relied on rainfed crop production and they have not yet been exposed to improved production technology, natural resource management and post harvest technology. Improvement of jhum areas was the main focus of the programme, but since the various components are interlinked; interventions have been carried out in an integrated way. Under the programme, training and demonstration programmes have been conducted on different aspects of jhum improvement like Improved production technology of fruits, vegetables and spices, community agro-forestry plantation in the jhum areas, nursery management of vegetable crops, soil and water conservation measures and water harvesting (Jalkund), community based value addition in fruits and vegetables, low cost vermicomposting technique, nutritional garden, mushroom cultivation, bee keeping, piggery, backyard poultry production, composite fish culture and integrated

farming system etc. Community inputs were distributed among the beneficiaries. One vaccination programme for pigs and one film show on composting was also organized at Purul village in Senapati district. Community mobilization and integrated approach was the crux of this program. Capacity building and skill enhancement of the farmers was emphasized throughout the implementation process. The programmes have created a good impact among the farmers.

Fig 44 Glimpses of TSP activities

Enhancing farm income of tribal farmers in Manipur through quality seeds

In the Seed Production programme under TSP taken up in different districts. In Churachandpur, 18 farmers took up seed production of rapeseed (M27) in an area of 17.25 ha. However due to drought, only 5.5 ha area produced yield of 11 q/ha. 10 nos of farmers were under seed production programme on Lentil (K-75). An area of 7.75 ha were covered to grow the crop producing seed yield of 1 q, whereas for Pea (Arkel) an area of 5 ha grown by 10 selected farmers. Similarly, for var. Rachana, seed yield of 0.70 q/ha was obtained from 1 ha area by a farmer out of the total five farmers in 5 ha area. In Ukhrul district, 225 kg of Rapeseed (M 27) were distributed in 24 farmers at TM Kashom and Tuinem villages of Ukhrul District. TSP Seed Production programme under pulse crops, 600 kgs of Pea (Arkel) and 200 kgs Pea (Rachana) received the benefit of 6 farmers including NGOs and VVD (Volunteer for Village Development) in different locations of Ukhrul district. Lentil 200 kg were also distributed under the programme to 13 nos of beneficiaries of TM Kashom village. But due to lack of rain during the season *rabi* crop should not succeed. Quality Production Programme of potato seed tubers (Kufri Jyoti) are being raised in Ukhrul District, Hungpung area and Ukhrul North area. Area covered were respectively 4320 kg and 2.17 ha, 5460 kg

and 2.73 ha and 12,000 kg and 6.00 ha. For summer, 53 farmers have been adopted under seed production of maize (Vijaya Composite) from the distribution of 400 kg of maize seed. In Chandel District, Rapeseed (M 27), Pea (Rachana, Arkel) and lentil were sown in 2, 2.5, 2 and 0.49 ha area respectively. Maize seed crops are being raised in different locations of Chandel district covering an area of 24 ha by 57 farmers. In rice (RC Maniphou 10) the total area covered under Imphal West were 1.70 ha by four farmers and 105 kg paddy seed was distributed. During *rabi* maize 130 kgs of maize seed has been sown by 4 farmers and cultivated in 4.95 ha area. Again 24 kgs of Rapeseed (M 27) were also distributed in four farmers for 2.90 ha area in different locations of Imphal West. Ten farmers belonging to Scheduled Tribe category from 5 different districts *viz.*,, Imphal West, Ukhrul, Tamenglong, Chandel and Churachandpur were trained on fabrication of low cost RC Seed Bin.

B. Pig production

Under the TSP Seed Production programme a total of 22 farmers including 2 (two) farmers clubs were randomly selected from 4 (four) villages in Ukhrul district i.e., Hundung (11), Lungshang (4) and Sanshak (7) and 104 nos. of weaned piglets were supplied along with 15 kg of pig starter ration per animal for initiation to local feeding methods. The total feed quantity of starter pig feed provided was 1560 kgs@ 15 kg/piglets. The body weight ranges from 8.2 to 18.4 kg at the initial stage. All the animals were vaccinated against swine fever with hog cholera vaccine after being dewormed with albendazole @ 10 mg/kg body weight as single dose.

D. Improved technology of groundnut production

One training programme and 14 demonstrations have been conducted on improved technology of groundnut production among the tribal farmers at Chandel, Churachandpur, Ukhrul, Tamenglong and Imphal West.

Fig 45 Training and demonstration activities in groundnut

Scientific maize production technology

One training programme on Scientific Maize Production Technology was organized at ICAR Research Complex for NEH Region, Manipur Centre in collaboration with Directorate of Maize

Research, New Delhi. The beneficiaries were trained on various aspects of improved package of practices for maize. Critical inputs like seeds and bio-organic inputs were distributed among the participants.

Fig 46 Training and demonstration activities in maize