

## **Executive summary**

Field crops research program was continued with the objective to increase the productivity of cereals (Rice, Maize, Wheat and other cereals), Oilseeds (Rapeseed-mustard) and grain legumes (Soybean and Groundnut). The strategies used were introduction and identification of suitable varieties and development of appropriate and affordable technologies that best suit the field conditions. The research activities were executed both in on station and on farm for evaluation and validation of technologies respectively.

In Rice, 11 lines in AET, 16 lines in IET and 15 lines in observation trial were tested in station for yield potential, optimum maturity, pests and diseases resistance and other agronomic traits. A total of 9 lines were selected for further evaluation. Selection of 7 populations from cross bred lines were continued with employing both bulk and pedigree method. They have now attained eighth generation. Study on new technology called System of Rice Intensification (SRI) has been started which needs further validation and confirmation.

Through BUCAP Program, few improved Rice varieties were tested in remotest villages of Taksha, Silly, Tsara and Adang under Wangdue Dzongkhag. Seed selection training to improve the local cultivars was also imparted. The sector has also carried out seed production and maintenance of Maize, Soybean, Groundnut, Wheat and Mustard for future use.

## **FIELD CROPS RESEARCH**

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### **1.1 Rice Research**

#### **1.1.1 Advanced Evaluation Trial**

With the aim to select suitable varieties with high yield potential, medium height, optimum maturity and resistance to pest and diseases for mid-altitude regions, 13 entries including a local and a standard checks were evaluated in 2007 season under Advanced Evaluation Trial. Some of the test entries were further evaluated while some were promising performers from Initial Evaluation Trial of 2006 season.

As per international norms, the trial was laid out in a randomized complete block design with three replications. Fourty five days old seedlings were transplanted in 10 m<sup>2</sup> plot with spacing of 20 cm x 20 cm. Chemical fertilizer was applied at the rate of 70:40:20 NPK kg/ha with half the N as top dress at panicle initiation. Butachlor 5G was applied at the rate of 1.5 kg a.i./ha after two days of transplanting to control the monocot weed and hand weeding at later crop period for controlling *Shoohum (Potomegaton distinctus)* and *Monochoria viganilasis*. Timely monitoring for pests/diseases incidence and irrigation were ensured.

Parameters like 50% flowering days, tiller numbers, plant height and grain yield were analysed using GENSTAT software. Grain yield was estimated from a harvest area of 5.04 m<sup>2</sup> and grain moisture content standardized at 14%. Statistically it showed that the tested lines had high significant difference from the standard and local checks in plant height and grain yield at 1% and 50% flowering days and tiller number at 5%. The promising lines have been selected for further evulation in the farmers' fields.

Table 1: Agronomic traits of entries in AET, 2007

Variety	50% flw (days)	Tiller No.	Plant height (cm)	Grain Yield (kg/acre)
IR 64683-87-2-2-3-3	127	16	92	2680
CT 6163-8-9-5-2-M-84-M	129	16	86	2400
DIANSHAO 3	141	15	97	2400
N 30	128	15	92	2520
IR 74052-165-3-2	136	16	91	2240
UPR 1561-6-3	123	15	82	2360
OM 1271	124	20	105	2440
IR 72176-140-1-2-2-3	130	20	92	2600
RCPL 3-6	140	16	100	2480
X 123	128	14	95	2640
IR 74642-195-1-3-2	139	17	89	2480
Zakha	128	17	120	2000
Bajo Kaap 2	127	14	94	3120
F	0.014*	0.03*	<.001**	<.001**
SED	5.16	1.83	2.34	0.41
LSD	10.66	3.7	4.84	0.86
CV%	4.8	13.5	3	8.4

\* significant at 5%, \*\* significant at 1%,

### 1.1.2 Initial Evaluation Trial

In the Initial Evaluation Trial, 18 entries were evaluated including a local variety and a standard check. The selection criteria were same as that of AET like grain yield, optimum maturity, and resistance to pests/diseases.

Randomized complete block design with three replications was used for the trial layout. Seedlings were transplanted in 10 m<sup>2</sup> plot with spacing of 20 cm x 20 cm. Chemical fertilizer was applied at the rate of 70:40:20 NPK kg/ha, with half the N top-dressed at panicle initiation. Butachlor 5G was applied at the rate of 1.5 kg a.i/ha to control monocot weeds. Hand weeding for *Shoohum* management and irrigation were done as per necessity.

A harvest area of 5.04 m<sup>2</sup> was used and grain moisture content was standardized at 14%. GENSTAT software was used to analyze the collected data. Statistically it showed that tiller number and grain yield of entries were significantly different from local and standard checks at 5% while flowering days and plant height had high significant difference at 1%. Four entries were selected for further evaluation in AET during 2008 season to ascertain the yield and other traits.

Table 2: Performance of entries in IET, 2007

Variety	50% flw (days)	Tiller No.	Plant height (cm)	Grain Yield (kg/acre)
GUI SI XUAN	128	17	89	2040
YN 96-5010	142	19	90	2280
CN 1227-3-13-53	127	19	94	2280
ANFC-3	128	18	95	2560
ANFC-4	136	15	92	2404
IR 72860-98-3-2-1	127	19	101	2880
MTU1010	128	20	93	2680
AT362	133	16	95	2640
IR 76187-10-2-1-1	126	18	97	2480
IR 74963-262-5-1-3-3	128	16	99	2600
IR 72997-159-2-2-1	144	19	94	2400
IR 73707-45-3-2-3	135	17	96	2120

IR 69736-145-1-2-3-3	132	20	97	2480
IR 77500-1-2-2-3	131	17	98	2400
BW 328-2	133	19	78	2800
BG 358	130	18	90	2400
Local	127	20	125	2120
Improved	128	19	89	2720
F	< 0.001**	0.01*	< 0.001**	0.006*
SED	1.4	1.2	5.8	0.51
LSD.	2.8	2.5	11.9	1.03
CV%	1.3	8.4	7.5	10.1

### 1.1.3 Observation Nursery

In 2007 season, 15 entries were evaluated in observation trial. The test lines were selection of IIRON nursery of the 2006 season. The objective of the trial was to further ascertain its performance in terms of yield, maturity period, pests and diseases resistance. The treatments were laid out in a single plot of 10 m<sup>2</sup> with the spacing of 20 x 20 cm. Inorganic fertilizers were applied at the rate of 70: 40: 20 NPK kg/ha. Crop management was done like other trials. While four lines were discarded due to disease mainly blast and threshing problem, six lines were identified for further evaluation. The selected lines include IR 70175, WAS 65, IR 78555, 94016-TR, IR 77700 and CT 8887.

Table 3: Agronomic traits of Observation nursery

Variety	Tiller No	Plant Height (cm)	Yield (t/ha)
IR 70175-51-2-1-1-2	16	103	2560
WAS 65-11-1-7-5-3	16	83	3080
CT 9874-3-2-M-5-4P-M	Discarded due to blast disease problem		
IR 72887-34-2-1-3	15	95	2240
IR 70181-32-PM1-1-1-4-2	14	94	2440
ANFC-2	Discarded due to blast disease problem		
IR 78555-68-3-3-3	14	94	2800
94016-TR 1585-2-1-1	15	99	2640
IR 77700-84-2-2-2	15	82	2640
K 429 (KOH SAR)	Discarded due to threshing problem		
IR 61608-3B-16-2-3	17	90	2280

IR 76919-99-2-3-2	Discarded due to threshing problem		
CT 8887-10-16-21	14	97	3240
IR 70182-18-PM1-4-UBN-1-B	13	90	2200
IR 68352-14-1-1-1	14	82	2000

#### 1.1.4 Rice breeding: Bulk and pedigree selection

The selections for uniformity in panicles, maturity, disease and pests' resistance and other desirable traits were continued from the four cross bred populations. Three populations at Wengkhar and seven populations at Mithun, Tsirang were evaluated for same traits by the respective researchers. The populations have now reached F8 generations.

Both pedigree and bulk methods of selections were employed. In the pedigree selection, a total of forty four panicles were selected whereas in bulk method sufficient amount of seeds of each accessions were collected for further selection. The selection and evaluation will continue till the lines attain uniformity.

Designation	Parents
1. IR 80484	IR 65598-112-2/Dago Yangkum
2. IR 80485	IR 65598-112-2/Local Yangkum (red)
3. IR 80490	IR 71684-36-3-3-2/Dago Yangkum
4. IR 80491	IR 71684-36-3-3-2/Local Yangkum (red)

#### 1.1.5 Demonstration of released varieties

The centre annually receives number of farmers, extension and visitors on study tours. In order to demonstrate them the characteristics of released rice varieties physically, the following rice varieties were established at the research station.

##### Varieties:

1. Bajo Kaap 1
2. Bajo Kaap 2
3. Bajo Maap 1
4. Bajo Maap 2
5. IR 64
6. IR 20913

7. Khangma Maap
8. Khumal 2 (Wengkhar Rey Kaap 2)
9. Yusi Ray Maap
10. Yusi Ray Kaap
11. BR 153
12. M 54

### 1.1.6 Seed Maintenance and production of released/promising varieties

Besides carrying out adaptive research, sector also maintains sufficient quantities of rice seed for demonstration or carrying out trial in new sites. Moreover the adhoc requests from Dzongkhags or Agriculture Extensions are met from such seed stock. Therefore the following quantities of seed of different released varieties were produced and maintained in 2007 season.

Table 5: Seed production of released varieties in 2007

Variety	Quantity (kg)
BR 153	222
Bajo Maap 1	500
Bajo Maap 2	500
Bajo Kaap 1	500
Bajo Kaap 2	500
Wengkhar Rey Kaap 2	200
Wengkhar Rey Kaap 6	119
Milyang 54	100
Mama	100
No 11	217
Khangma Maap	154
IR 64	1000
IR 20913	700
Yusirey Kaap	82
Yusirey Maap	100
Barket	84
<b>Total</b>	<b>5078</b>

In addition the following quantities of promising and pipeline varieties were produced and maintained for further evaluation in multilocation trial.

Table 6 : Seed production of Promising varieties in 2007

Variety	Quantity (kg)
GUOJING 4	500
B 298 B-SR-85-3-2-4	300
NR 10291	100
YOUMI 18	150
RHS351-19-CX-7CX-2CX	200
<b>Total</b>	<b>1250</b>

### 1.1.7 Observation of SRI (System of Rice Intensification)

The evaluation of SRI (System of Rice Intensification) was continued in 2007 season with the main objective to observe the performance of SRI under Bhutanese condition. Its 4 guiding principles namely early seedling transplanting, single seedling transplanting, wide spacing and keeping soil conditions moist but not flooded at early stages were followed. An improved variety Bajo Maap 2 was tested with the following treatments

**T1-** SRI (FYM application (10000 kg/ha), 14 days old seedling, 30 x 30 cm, no chemical fertilization)

**T2-** Research Recommended practice (30 days old seedling, 20 cm x 20 cm, chemical fertilization (NPK 70:40:20 kg/ha), butachlor application (30 kg/ha)

**T3-** Farmer's Practice (FYM application, 50 days old seedling, random transplanting, no chemical fertilization)

**T4-** Modified SRI (Same as T1 but Butachlor application and Urea Top dress)

The trial was laid out in randomized complete block design with 3 replications. The soil was kept moist till flowering in T1 and T4 where as normal irrigation water was maintained in T2 and T3. Hand weeding was done twice for weed management and soil aeration. Crop cut was taken from an area of 5.04 m<sup>2</sup>.

Statistically it showed that there was yield difference among the treatments at 1% level. The yield from the SRI plot was lowest which may be attributed due to non fulfilment of all its requirements. However there is need for further evaluation and validation of this technology. Some of the constraints encountered were preparation of well levelled field, handling of young seedlings and control of irrigation water.

Table 7: Agronomic traits of SRI 2007

Treatments	Tiller No.	Plant ht (cm)	Grain Yield (kg/acre)
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SRI (T1)	17	117	1612
Recommended Practice (T2)	20	108	2492
Farmer's practice (T3)	18	97	2320
Modified SRI (T4)	19	115	1680
F	0.67**	0.01**	<.001*
SED	2.26	4.3	0.30
LSD	5.5	10.6	0.74
CV%	14.8	4.9	7.4

## 1.2 BUCAP activities in the West-Central region

The BUCAP activities for west central region coordinated by National Biodiversity Centre, Thimphu and facilitated by RNRRC, Bajo for 2007 season had been successfully implemented in the project sites with the broad objective of conserving and developing agricultural biodiversity and strengthening farmer's capacity. In addition to the existing sites, Taksha, Silli and Tsara of Daga geog under Wangdue Dzongkhag were also included as BUCAP sites from 2007. The major activities undertaken in 2007 were the Participatory variety selection, Vegetable Promotional Program and capacity building on seed selection/purification. The activities were implemented in collaboration with the Dzongkhag Agriculture Sector and Gewog Agriculture Staff.

### A. Taksha and Silli

#### 1.2.1 Participatory Varietal Selection

Four different improved varieties namely Khangma Maap, Machapucherey-3, Yusiray Kaap and Yusiray Maap were evaluated along with their local variety as check. Nursery was sown in April and crop was transplanted in mid June. All the management practices were that of existing farmer's practice without detecting the practices either by the researchers or extension. Butachlor application at the rate of 10 kg/acre after 2 days of transplanting to control the weed is a common practice but inorganic fertilizers are not applied either as basal or top dress. Research and Extension facilitated the activity with timely monitoring.

From the crop cut results it was found that Machapucherey-3 was the highest yielder followed by their local variety, Machum. Khangma Maap yield was also appreciable but farmers were reporting of rodent attack due to its early maturity. Yusiray Kaap and Yusiray Maap were all sterile despite raising nursery and transplanting at same time. Therefore crop cut could not be taken from these two varieties. Farmers opted to try Machapucherey-3 in large scale from the ensuing season with the seed support from RNRRC Bajo.

Table 8: Crop cut results at Taksha in 2007

Variety	Grain Yield (Kg/Acre)	Remark
Khangma Maap	1240	Introduced Red variety
Machapucherey-3	1504	Introduced White variety
Machum (Local)	1488	Local (Red) variety

### 1.2.2 Seed Selection Training

There is need for imparting seed selection training as the farmer's only local variety is all mixed or rather deteriorated. It is clearly visible through different colours of panicles. Farmers were asked about their normal practice of selecting seed for next year's planting which they explained that they used to identify a plot or terrace and all rouging of off types are done prior to harvesting. Seeds are selected by women only. However they themselves are not sure whether all the off types have been removed or not. The harvested crop is then heaped and later threshed, sun dried and used for seed. During the critical situation like insufficiency of food, the seed is used as food and farmers borrow from neighbours which are still uncertainty of good quality seed. Some farmers were reported of using seed even from the general harvest that is meant for consumption.

Farmers were explained about the advantages of good quality seed. They were also briefed on symptoms of poor seed which ultimately leads to poor yield. They were commented that their present practice of site selection and rouging is good but if any of the off types, immature plants or diseased plants are left during rouging by mistake, and it goes as seed. Therefore they were urged that panicle selection for seed purpose is the recommended and best method for qualitative seed selection. The panicles which are well matured, disease free and compact should be selected and harvested prior to general harvest. The selected panicles

should be then well sun dried and stored separately for next year's seed. They were also told that panicle selection will lead to uniformity of crop stand. Farmers were then involved for practical panicle or seed selection of Machum. Around 10 kilograms of seed were selected.

Farmers said that the method of panicle selection for seed purpose was never known before. They revealed that though time consuming, this method will be of immense help in improving the local variety especially in terms of crop uniformity and yield. They assured that they will practice seed selection in their respective fields and observe the difference between selected and non selected seed next year. It was discussed that the seeds that were selected during the training will also be evaluated in a common study plot to observe the difference participatorily.



Picture 1: Seed selection exercise at Taksha

### **1.2.3 Participatory Varietal Selection at Silli**

Two improved varieties namely Khangma Maap and Machapucherey-3 were evaluated along with their local variety as check. Nursery was sown in mid April and crop was transplanted in mid June. All the management practices were that of existing farmer's practice. Farmers do apply Butachlor to control weed but inorganic fertilizers both as basal and top dress are not applied.

A field day was conducted during the harvest time to participatorily evaluate the varieties, gather farmer's feed backs and plan future course of actions.

The crop cut result revealed that their local variety, Machum yielded higher than Khangma Maap. However the yield difference was not that significant as Khangma Maap was damaged by rodent during the tillering stage. Crop cut could not be taken from Mchapucherey-3 as the crop was totally damaged by rodents. Farmers confessed that herbicide could not be applied to the PVS plot and timely hand weeding was not carried out thereby succumbing the crop to rodent attack. Therefore it was agreed that farmers will evaluate the varieties individually from 2008 season but whenever there are group works or group mobilization, all will come together.

Table 9: Crop cut results at Silli in 2007

Variety	Grain Yield (Kg/Acre)	Remark
Khangma Maap	780	Introduced Red variety
Machapucherey-3	-	Totally damaged by rodent
Machum (Local)	812	Local ( red) variety

#### 1.2.4 Seed Selection Training

The problem of seed deterioration was also found in this village too. The practice of keeping seed is same as that of other village Taksha. They were never taught and not aware of panicle selection for seed purpose. Therefore a day long seed selection training was imparted to the farmers as that of Taksha. They felt that it would be interesting to see the effect of panicle selection and normal seed selection in uniformity and yielding ability. Besides their own selection, it was discussed that seed harvested during the training will also be evaluated to observe the difference.

### **1.2.5 Material support**

In order to reduce the drudgery of paddy threshing, BUCAP have supplied 2 paddy threshers each for Silli and Tsara village and 3 paddy threshers for Taksha village. They were grouped as per the location and convenience to transport the thresher during threshing time. The supply of thresher is expected to reduce the labour and time requirement in threshing the paddy thereby getting more time to attain other agricultural activities. The supply is also expected to boost and motivate the farmers in implementing the BUCAP activities which will contribute to Plant Genetic Resources (PGR) conservation and development directly or indirectly. A simple demonstration on use of thresher was organized.



Picture 2: Demonstration on use of paddy thresher

## **B. SAMTHANG**

### 1.2.6 Promotion of B 2983B SR Rice variety

As per the demand and interest for the above variety which was the selection from the previous PVS plot, 20 kilograms were supplied for further evaluation in their respective fields. The variety was found to be promising and farmers were optimistic to continue the variety for the following season (s).

Table : Crop cut results in 2007

Variety	Yield (Kg/Acre)	Remark
Attey	1120	Local and white variety
B2983B-SR	2000	Introduced and red variety

### 1.2.7. Vegetable Promotional Program

BUCAP continued supplying free vegetable seeds like Radish, Beans, Chilli, Brinjal and Mustard Green to the farmers. The free supply was to motivate and encourage farmers to go for vegetable cultivation for their household consumption as vegetable cultivation is new to the community. The vegetable researcher backstopped them technically and taught about seed production aspects to sustain in the future. With continuous monitoring and motivation, farmers are now developing a kitchen garden where they grow diversity of vegetables. However there is need for further support till the farmers are equipped with complete package of practices.

## 1.3 Wheat Research

### 1.3.1 Observation Trial of Nepal Advanced Lines (NAL)

In 2007-2008 season, 48 test lines were evaluated with the objective to assess the performance of these lines under Bhutanese agro-ecological conditions in terms of yield, disease resistance and other agronomic traits. The trial was laid out in an area of 6m<sup>2</sup> with the spacing of 20 x 20 cm. Inorganic fertilizer was applied at the rate of 60:30:20 NPK kg/ha with timely hand weedings and irrigation.

Eighteen lines yielded more than 400 kgs/acre (1 t/ha) and were selected for further evaluation. The poor yielders and rust susceptible lines were discarded.

Table 10: Agronomic traits of Nepal Advanced Lines

Lines	Plant ht. (cm)	Yield (kg/acre)
BL3072	76	440
BL3083	82	240
BL3093	82	600
BL3099	83	400
BL3100	71	200
BL3111	66	280
BL3112	69	400
BL3115	83	600
BL3116	93	200
BL3118	83	400
BL3121	87	760
BHIRKUTI(Check)	80	480
BL3122	77	560
BL3124	76	360
BL3125	80	400
BL3126	81	480
BL3128	73	280
BL3131	80	160
BL3134	75	320
BL3135	70	200
BL3153	60	200
BL1887 (Check)	64	200
BL3158	65	440
BL3162	66	280
BL3166	59	280
BL3174	67	400
BL3192	71	280
BL3201	75	760
BL3204	69	160
BL3205	72	280
BL3206	77	360
BL3218	72	320
BL3223	58	280
W462/VEE/KOEL/3/PEG//MRL/BU C	65	280
ALTAR84/AESQUARROSA(219)//3	63	520

*ESDA		
W462//VEE/KOEL/3/PEG//MRL/BU C	76	120
PBW65/2*SERI.1B	74	160
PRL/2*PASTOR	70	320
BL2936	78	400
BL2982	74	400
BL3020	66	240
BL1887 (Check)	74	400
BL3021	73	360
BAW966	77	160
BL2890	72	240
BL2892	74	360
BL2981	68	360
CNDO/R143//ENTE/MEX12/3/AEGI LOPS	70	160

### 1.3.2 Seed production & maintenance of released and promising lines

The following quantity of seeds of different released and promising varieties were produced and maintained at research centre for future use.

Table 11: Wheat seed produced in 2007

Variety	Quantity (Kg)
Bajoka-1	15
Bajoka-2	18
Sonalika	20
Pasang Lhamu	15
Anapurna 4	20
HD 2189	12
VL786	15
UP 262	10
Total	125

### 1.4. Oilseeds Research



### 1.4.1 Seed maintenance and production of released oilseed crops

The following quantities of oilseed crops were produced:

Table 12: Mustard seed production

Variety/Type	Quantity (kg)
Bajo Peka-1 (BSA)	12
Bajo Peka-2 ( PT-30)	6
M-27	5
T-9	5
Lumley Local	9
Total	37

## 1.5 Grain Legumes

### 1.5.1 Seed production and maintenance of Soybean and Groundnut

The following quantities of released and promising Soybean and groundnut varieties were produced and maintained for research purpose in the future:

Table 13: Soybean seed production

Variety	Quantity (kg)
AGS 258	30
Bragg	16
Japanese Black Grade LL	24
Japanese Black Grade L	20
Chinese Black Variety 2	11
Nepal 1	24
Total	125

Table 14: Groundnut seed production

Variety	Quantity (kg)
Kadiri	6
ICGV 87920	7
ICGV 86699	33

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Total	46
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## 1.6 Maize

There has been no Maize varietal evaluation in the station as RNRRC Wengkhar is mandated on Maize research. However the foundation seed production was carried out in the station for ensuing season use or supply to extension.

Table 15 : Maize seed production

Variety	Quantity (kg)
Yangtsipa	311
Khangma Ashom I	71
Khangma Ashom II	128
Sweet corn	25
Pop corn	15
Total	550

## 1.7 TSIRANG SUB CENTRE

### 1.7.1 Bulk selection of cross bred lines

The lines that were bred through shuttle breeding at IRRI, Philippines were evaluated at Tsirang for uniformity in panicles, maturity, disease and pests' resistance. There were a total of seven populations.

The crop health was not that good mainly due to shortage of irrigation water thereby delaying the transplanting. However vigorous selection was done and around one kilogram of seed was bulked from each population. It was planned that the selection be continued in the following season with the harvested and backup seed from Bajo as there is hope that few populations may perform well if transplanted on time.

Designation	Parents
1. IR 80486	IR 65598-112-2/Attey
2. IR 80487	IR 65598-112-2/Choti Masino
3. IR 80488	IR 65598-112-2/Sukhimey
4. IR 80492	IR 71684-36-3-3-2/Attey

- |             |                                |
|-------------|--------------------------------|
| 5. IR 80493 | IR 71684-36-3-3-2/Choti Masino |
| 6. IR 80494 | IR 71684-36-3-3-2/Sukhimey     |
| 7. IR 80497 | IR 71684-36-3-3-2/Choti Masino |

### 1.7.2 Seed production and Maintenance

The centre carried out foundation seed production mainly for two improved varieties that are suitable and promising under Tsirang environment. The maintained seed will be supplied to extension or farmers for further dissemination.

Table 16: Seed production in 2007

Variety	Quantity (kg)
Wengkhar Rey Kaap 2	135
Wengkhar Rey Kaap 6	145
Total	280

### 1.7.3 Maize seed production

The following quantities of released Maize varieties were produced and maintained for ensuing season use.

Table 17: Seed production in 2007

Variety	Quantity (kg)
Yangtsipa	78
Khangma Ashom II	38
Total	116