DEVELOPMENT OF MODERN UPLAND RICE (*Oryza sativa* L.) VARIETIES, WITH SUPERIOR MILLING AND PHYSICO-CHEMICAL TRAITS, FOR PAPUA NEW GUINEA.

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ABSTRACT

To select suitable upland variety(ies), the tailor made germplasm was imported from IRRI. After preliminary evaluation, six genotypes were selected. In both the confirmatory trials, under severe drought, selections ADT 31, IAC 165, IR 47686-6-2-2-1, IRAT 104 and Niupela outyielded the rest of the selections. The Regional yield trials on these promising varieties were conducted country wide during 1993, in comparison to either Niupela or a locally grown variety in the respective area (Finschafen) or other genotypes we have developed so far. IAC 165, ADT 31, IR 47686-6-2-2-1, IRAT 104 and Niupela proved their high yielding potentials in these regional yield trials. IAC 165 & ADT 31 are one month early maturing than the rest. The varieties IAC 165, IR 4768-6-2-2-1, IRAT 104 & Niupela possess good milling recovery and most of their physico-chemical traits are desirable. IAC 165 has very low amylose contents, but cooks as soft as IRAT 104 & IR 47686-6-2-2-1. Therefore it may be suitable as a glutinous variety. The varieties IRAT 104 & IR 47686-6-2-2-1 seem to be good for upland cultivation in the country.

Key words: *Upland, germplasm, yield components, selection, adaptability trials, milling & physico-chemical traits.*

INTRODUCTION

Upland rice means a rice crop grown under scarce moisture, either on flat bunded or undulated unbunded fields. The fields are prepared and planted under dry condition. The crop depends on natural precipitation.

Upland rice is cultivated in the poorest countries of the world, in three continents viz. Asia, Latin America and Africa. Grain yields are low and vary from 0.5 t/ha in Africa, 0.5 to 1.5 t/ha in Asia and 1.0 to 4.0 t/ha in Latin America (De Datta 1975). But the area under upland rice is so large that a small increase in yield substantially affects the total upland rice production of the world. Like some other upland rice growing countries, PNG can also become self sufficient in rice, if she harnesses the niche for rice production.

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The last consultancy study to PNG (Sloan & King 1993) for, "Rice Sites development study" has emphasised the development of a rice based farming system (RBFS) approach to achieve this goal. In the proposed farming system, rice is one of the many crops, but not the only crop. They have also suggested that rice should be grown by partial irrigation, by harnessing the sub soil water.

But since rice is entirely a new & labour-intensive crop in PNG, we strongly suggest that rice should be promoted as a mono crop for at least next 10 years. This will certainly develop expertise of local scientists and rice farmers. RBFS will in fact at this stage of Agricultural development will open a Pandora box: and both the scientists and farmers will be like rolling stones; and will never gather masses.

However, the dream of developing many crops is realizable, only if the proposed RBFS is technically robust and economically viable; and farmers of the country are ready to be recipients of the new approach.

As a step towards making that ambitious dream realizable, we have envisaged some of the constraints for rice production for lowland, upland high altitude areas with cool climate and acid soil ecosystems of PNG. These constraints are non availability of modern High Yielding Varieties (HYV's) and lacuna in agronomic information to make the rice cultivation cost effective in the country. Therefore to tackle these two major problems for higher and sustainable yields of rice, we initiated a project, during the last quarter of 1990 on, "Breeding of modern High Yielding Varieties (HYV's) for lowland, upland, high altitude areas with cool climate & acid soils ecosystems and development of Agronomic practices, for lowland and upland ecosystems".

The development of varieties for upland was given a special emphasis and the progress on the area of research is reported in this paper. The progress of development of modern HYV's for lowland, high altitude areas with cool climate and acid soils will be presented elsewhere.After our preliminary evaluation of the potential of Markham valley, during 1991 for upland rice cultivation, semi mechanized-with medium inputs comercial trials (Sajjad and Beko 1994) & variety trials in the valley, we could successfully pin point an extremely promising variety for upland cultivation called Niupela (Wohuinangu & Sajjad 1992). Chang *et al.* (1974) have reported that many traditional upland rice varieties produce fully filled panicles with heavier grains, inspite of drought. We have also observed such a capability in Niupela, while testing it country wide for upland cultivation.

The variety posseses good agro-botanical traits, milling recovery & is being promoted by us, for the whole country. Niupela is short grain variety and is easier to harvest by hand, and has greater consumer acceptance (Fereday 1993). We had found the variety very promising during 1992 and since then its seed was multiplied on a top priority basis and has literally spread to every nook and corner of the country.

But since we envisaged avoiding the narrow genetic base for future upland varieties for the country from the very beginning, we are striving very hard to develop a gene source to act as donors of drought tolerance to develop future varieties by hybridization. Therefore, we tried to develop our gene bank by selecting more drought tolerant varieties, possessing either avoidance phenomenon i.e. early maturity or in possession of such Agro botanical traits, enabling them to cope effectively with drought.

It has been reported that the exotic germplasms of wide geographic origin possess the genetic plasticity to cope with adverse environments (Sajjad 1983, 1987). This prompted the present study to select suitable upland rice variety(ies) for PNG.

MATERIALS AND METHODS

The entries (53) of a set of high light entries of International Rice Testing Programme (IRTP-1991), were evaluated under ERDC conditions, in comparison to Niupela as the local standard. The experiment was planted on 19.10.1991 and was harvested on 6.2.1992. Each entry was planted on 2, 15 m - long rows per replication. the experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. The crop received N,P,K at the rate of 150:75: 75 Kg/ha respectively. The data on yield and yield components were recorded on 20 guarded plants per entry per replication.

Two confirmatory trials were conducted, under very severe drought condition, under upland field at ERDC & Finschhafen, during 1992. The following six selections were tested, in comparison to Niupela.

1. ADT 31 (IR 8/Culture 340, from India).
2. IAC 165 (from Brazil).
3. IR47686-6-2-2-1 (IRAT104/Palawan, from IRRI).
4. IR 47686-9-2-B (IRAT 104/Palawan, from IRRI).
5. IRAT 104 (IRAT 13/Moroberekan, from Ivory Coast).
6. IRAT 13 (Mutant of 63-83, from Ivory Coast).

The crops were planted with a dibbling stick at plan to a row distances of 20 cm. The experiments were conducted in RCBD, with four replications. Each entry was planted on 9 m.sq. area per replication. Both the crops received N,P,K at the rate of 100:50:50 Kg/ha respectively.

The experiments were planted on 16.3.1992 (ERDC) & 24.4.1992 (at Ubegon Seven Lally Youngpela didiman Farm, Finschhafen). The crops were harvested on 17.7.1992 and 26.8.1992. The early maturing genotypes ADT 31 & IAC 165 were harvested one month before the rest of the lines, at both the sites. To record the data on fresh paddy weight, a net area of 4 m.sq (100 hills area) per entry per replication was harvested. The crop was threshed on the spot and data were recorded. The data on fresh paddy weight was later adjusted to 14% moisture contents. The data on yield components were recorded on 15 plants per entry per replication. The data were statistically analyzed by using DMRT.The regional yield trials were planted at Finschhafen, Bereina and ERDC, during 1993 to determine the yield potential and adaptability of the varieties.

Finschhafen. The comparative yield potential of most promising new varieties, and Niupela were tested in comparison to a variety (designated hereafter as Fins. (Finschhafen 91) already under cultivation in the area. The experiment was planted on 11.2.1993, at Walingai Yangpela Didiman Farm, near Sialum. The three varieties were planted at plant to row distances of 20 cm. Each variety was planted on an area of 9 m² per replication. The experiment was conducted in RCBD, with five replications. The crop received no fertilizer.

The most early maturing variety IAC 165 was harvested on 6.5.93, while the rest of the varieties were harvested at their maturity. To record the data on yield, the plants from a net area of 6 m. sq. (area of 150 hills) per entry per replication were harvested & threshed on the spot; and the data on fresh paddy weight was recorded. Fresh paddy weight was later adjusted to 14% moisture contents. The data on yield components were recorded on 15 plants per entry per replication. The data were statistically analyzed using DMRT.

Bereina, Central Province. Six genotypes namely IR 35366-62-1-2-2-3 (IRRI), S 8118-10-2 (Korea), IAC 165 (Brazil), Luke-3 & RP 1515-221-3-3-1 (India) and Niupela (standard)) were studied. The trial was conducted in RCBD, with five replications. Each genotype was planted on an area of 15 m² per replication. The planting (on 24.3.1993) was accomplished with a dibbling stick, at plant to row distances of 20 cm. The depth of sowing was kept uniform. The crop received N,P,K at the rate of 33:50:50 kg/ha respectively, only as a basal application. The most early maturing variety IAC 165 was harvested on 22.6.1993. The rest of the genotypes were harvested after about one month. Fresh paddy weight was recorded after harvesting a net area of 6 m² per entry per replication. The data on fresh paddy weight recorded were adjusted to 14% moisture contents. The data for yield components were recorded on 15 hills per entry per replication. The data were statistically analyzed using DMRT.

ERDC. The most promising selections; ADT 31, IAC 165, IR 47686-6-2-2-1, IR 47686-9-2-B, IRAT 104, IRAT 13 and a Nepalese variety KK-15-36-C (IR 5657-33-2/BKNBR 1031), for the lowland were yield tested in comparison to Niupela as standard. The rice plants were planted on 1.12.1993, at plant to row distances of 20 cm using a dibbling stick. The experiment was conducted in RCBD, with five replications. Each entry was planted on an area of 15 m² per replication. The crop received N,P,K at the rate of 100:50:50 Kg ha^{-1} respectively. Weeding was done only once, due to less recources available for the work. The crop was harvested on 7.4.1994. To record the data on yield, a net area of 6 m² per entry per replication was harvested and fresh paddy weight recorded. The data on fresh paddy weight were adjusted to 14% moisture contents. To record the data on yield components, 15 hills per entry per replication were harvested separately and stored in separate paper bags. The data on panicle traits were recorded in the laboratory. The data were statistically analyzed using DMRT.

EXPERIMENTAL RESULTS

The results of the preliminary evaluation of 53 entries (IRTP-1991), in comparison to Niupela as local stand-

Table 1. **Performance (yield and yield components) of most promising selections from the high light entries for International Rice Testing Programme (IRTP) 1991, under upland field condition at ERCD, during 1992.**

Name	Days to 50% flowe-ring	Plant height (cm)	Prod-uctive tillers per hill	Panicle length (cm)	Grains per panicle	Spikelet fertility (%)	Thou-sand grain weight(g)	Yield per hill (g)
ADT 31	65b	72.2c	21.2a	19.4c	68.2d	79.2b	21.8c	22.8c
IAC 165	65b	103.7b	12.7b	23.1a	120.8a	90.2a	34.1a	41.6a
IR 47686-6-2-2-1	91a	113.0a	12.4b	22.0ab	71.1d	82.0b	29.8b	24.4b
IR 47686-9-2-B	93a	111.8a	10.6b	23.7a	96.0b	71.8b	29.9b	22.5c
IRAT 104	94a	112.5a	8.6c	24.1a	119.5a	83.1b	31.2a	23.2c
IRAT 13	93a	103.4b	10.6b	22.3a	79.9c	72.1b	33.9a	20.2d
Niupela	91a	104.5b	11.5b	20.1c	48.7e	45.6c	22.5c	12.9e

Figures followed by different letters are significant at 5% level, according to DMRT.

Table 2. **Performance (yield and yield components) of selections from IRTP-1991 & a Standard in a microplot yield trial at ERDC, during 1992.**

Genotypes	Days to flowe-ing	Yield t/ha	Plant height (cm)	Productive tillers/hill	Panicle length (cm)	Grains per panicle	Spikelet fertility (%)	Thousand grain weight (g)
ADT 31	63b	2.6a	56.0d	12.0a	21.1c	65.8b	70.0c	19.5c
IAC 165	60b	2.7a	73.4c	6.3c	16.9d	87.9a	71.5c	20.9d
IR 47686-6-2-2-1	90a	2.5a	93.3a	4.6d	23.6a	50.3d	62.9d	28.9b
IR 47686-9-2-B	88a	1.9b	86.2b	6.3c	21.7b	60.1c	70.7c	27.0c
IRAT 104	90a	2.5a	86.3b	4.1d	24.1a	58.9c	75.5b	33.5a
IRAT 13	88a	1.5b	70.5c	4.1d	20.9c	51.7d	58.1c	29.4b
Niupela	90a	2.6a	98.8a	7.5b	23.7a	91.5a	80.0a	19.4c

Figures followed by different letters are significant at 5% level, according to DMRT

ard indicated that lot of variability existed not only among varieties, but also among the various plant attributes studied.

Based on the performance for yield and yield components, phenotypic acceptability at maturity, ripening colour, tolerances to insect pests and diseases and various paddy characteristics, 6 most promising genotypes viz. IAC 165, IR 47686-6-2-2-1, IRAT 104, ADT 31, IR 47686-9-2-B and IRAT 13 were selected for further studies. The characteristics of these promising selections are presented in Table 1. It is evident that IAC 165 & ADT 31 are the most early maturing; and IAC 165 the highest yielding. The tallest plant height were of IR 47686-6-2-2-1, IR 47686-9-2-B & IRAT 104. ADT 31 produced the maximum number of productive tillers per hill, IAC 165, IR 47686-9-2-B, IRAT 104 & IRAT 13 the longest panicles, IAC 165 & IRAT 104 maximum grains per panicle. The spikelet fertility was maximum for IAC 165 and the heaviest grains were produced by IAC 165, IRAT 104 & IRAT 13.

The results (Table 2) of a confirmatory trial at ERDC show that both ADT 31 and IAC 165 were the earliest flowering. ADT 31, IAC 165, IR 47686-6-2-2-1, IRAT 104 (at par with each other) were the highest yielding.

Table 3. **Performance (yield and yield components) of selections from IRTP-1991 & standard in a micro plot yield trial at Finschhafen (Ubegon Seven Laly Youngpela Didiman Farm) under upland field, during 1992.**

Designation	Days to flower	Yield t/ha	plant height (cm)	Productive tillers perhill	Panicle length (cm)	Grains per panicle	Spikelet fertility (%)	Thousand grain weight (g)
ADT 31	67c	3.5a	61.2f	16.2a	22.5bc	110.2c	79.2ab	20.5
IAC 165	59d	3.6a	120.0c	14.9a	23.9b	125.9b	80.0a	30.7a
IR 47686-6-2-2-1	90b	3.1a	94.5d	7.9b	22.9bc	113.8c	78.0c	30.7a
IR 47686-9-2-B	88b	2.6b	90.4d	5.9c	22.9bc	102.9d	71.9c	28.1c
IRAT 104	90b	3.2a	86.9d	8.0b	24.5b	101.8d	76.8d	28.5c
IRAT 13	86b	1.8b	76.1e	7.5b	23.0bc	104.7d	75.7e	29.1b
Niupela	90b	3.0a	145.0b	8.7b	24.50b	150.4a	80.9a	27.9c
Finschhafen 91	118a	3.0a	160.0a	14.5a	25.8a	135.4b	79.7ab	28.5c

Figures followed by different letters are significant at 5% level, according to DMRT.

Table 4. **Performance (yield & its components) of different varieties, under upland field condition at Walingai Yangpela Didiman Farm, Finschhafen, during 1993.**

Variety	Days to flower-ing	Yield (t/ha)	Plant height (cm)	Productive tillers/hill	Panicle length (cm)	Grains per spike	Spikelet fertility (%)	Thousand grain weight (g)
FINS. 91	145a	3.0b	163.7a	16.0b	26.7a	140.9a	91.7a	30.0a
Niupela	125b	3.4a	151.1b	8.5c	25.4b	155.7a	91.0a	27.8b
IAC 165	85c	3.5a	123.8c	26.9a	24.0b	150.8a	92.5a	30.5a

Figures followed by different letters are significant at 5% level, according to DMRT.

Niupela and IR 47686-6-2-2-1 were the tallest of all the varieties under test and the tillering capacity was maximum for ADT 31. The panicle length of IR 47686-6-2-2-1, IRAT 104 & Niupela was maximum and the highest no. of grains per panicle were produced by Niupela and IAC 165. Spikelet fertility % was the highest for Niupela and IRAT 104 produced the heaviest grains. However, due to dry months, the performance of all the entries for yield and yield components was not good. This was largely due to the drought at the time of grain-filling stage in the area. But this proved a panacea for our confirmatory investigation for correct assessment of relative drought tolerances of the strains under test.

The results (Table 3) of another confirmatory trial at Finschhafen indicated that varieties IAC 165 & ADT 31 were the earliest flowering & the varieties ADT 31, IAC 165, IR 47686-6-2-2-1, IRAT 104, Niupela, and Fins. 91 (at par with each other) were the highest yielding. Fins. 91 was the tallest of all the varieties; and tillering capacity was maximum for ADT 31, IAC 165, & Fins. 91 (at par with each other). Fins. 91 produced the longest panicle, and Niupela produced the highest number of grains per panicle. The spikelet fertility was maximum for IAC 165 & Niupela. The heaviest grains were produced by IAC 165 & IR 47686-6-2-2-1.

The results (Table 4) of a regional yield trial at Finschhafen indicated that IAC 165 was the earliest flowering; and, Niupela and IAC 165 (at par with each other) were the highest yielding, Fins. 91 was the tallest of all the varieties under test, followed by Niupela and IAC 165. The tillering capacity of IAC 165 was the highest followed by Fins. 91 and Niupela. The panicle length of Fins. 91 was the maximum, while the trait was

Table 5. **Performance of different selections in a Regional Yield Trial at Kivori Village, Central Province, under upland field condition during 1993.**

Designation/origin	Yield (t/ha)
IR-35366-62-1-2-2-3	1.5b
Luke 3	2.5a
S 8188-10-2	1.2b
RP 1515-221-3-3-1	1.6b
IAC 165	2.5a
Niupela	2.9a

Figures followed by different letterers are significant at 5% level, according to DMRT.

Table 6. **Comparative yield potentials of very promising selections for upland, in a Regional yield trial, at ERDC, during 1993.**

Name	Yield (t/ha)
ADT31	2.5a
IAC 165	2.6a
IR 47686-6-2-2-1	2.3a
IR 47686-9-2-B	1.9b
IRAT 104	2.4a
IRAT 13	1.5c
Niupela	2.1b
Tai Chung Sen 10	1.9b
KK-15-36-C	1.3c

Figures followed by different letters are significant at 5% level of significance according to DMRT.

Table 7. **Total milling recovery potentials of the most promising selections (in advanced stage of testing) standard varities for upland ecosystem of PNG.**

Variety	Total milling recovery %
FINS.91	53
Niupela	58
ADT 31	53
IAC 165	59
IR 4768-6-2-2-1	57
IR 47686-9-2-3	55
IRATP 104	58
IRAT 13	56
IR 29725-117-2-3-3	57
IR 5040-57-2-2-3	57
IR 52287-15-2-3-2	53
BG 932	58
Sanduangzhan No. 2	58
Tai Chung Sen 10	58
KK-15-36-C	59

at par with each other for Niupela and IAC 165. The rest of the attributes for the three varieties were at par with each other, except thousand grain weight.

The results (Table 5) of the Regional yield trial at Bereina indicated that yield of IAC 165, Niupela and Luke-3 was the highest among all the genotypes studied. It is very interesting to note that Luke 3 was developed for lowland cultivation, but has performed equally well for upland growing conditions. The yield of rest of the entries viz. IR 35366-62-1-2-2-3, S8188-10-2 and RP 1515-221-3-3-1 was statistically at par with one another.

The results (Table 6) of a Regional Yield trial conducted at ERDC, indicate that the yield potential of ADT 31, IAC 165, IR 47686-6-2-2-1, IRAT 104 (at par with one another) was the highest of all the entries.

Milling studies. The milling studies for all the genotypes tested in this investigation were accomplished with Satake laboratory huller and polisher. The paddy was sun dried consecutively for 4-5 days in the clear sun, to bring down the moisture contents in the vacinity of 11-12%. An equal amount of paddy was weighed and milled. Both the broken and head rice were weighed together to calculate the totalling milling recovery. The milling recoveries (Table 7) for IAC 165, Niupela, IR 47686-2-2-1, IRAT 104 were the highest, followed by rest of the genotypes under study. Variety ADT 31 performed very poorly for milling recovery.

Physico-chemcial traits. Some of the physico_chemical traits (Table 8) provided by IRRI, for some of the genotypes under study indicate that the varieties IRAT 104 & IR 47686-6-2-2-1 have very desirable physico-chemical traits. Both the varieties have 18% amylase contents, intermediate to high alkali digestion and possess almost similar gel consistencies. Their grains are long and are free from white belly character. The variety ADT 31 posesses very chalky grain & medium amylose contents (25%).

DISCUSSION

The results of the three regional yield trials clearly indicate the more or less superiority of IRAT 104, IR 47686-6-2-2-1, IAC 165, Niupela and ADT 31. The discrepancy for yield potentials of the varieties at some locations may be due to genotypes x environment interaction caused by different times of planting, rainfall, soil types etc. Among the four highest yielding

Table 8. **Some physico-chemical characteristics of modern High Yielding Varieties for upland rice cultivation in PNG.**

Designation	Nature of brown rice length	Brown rice shape	Chalkiness of endosperm	Alkali digestion	Amylose contents %	Gel consistency
ADT 31	short	round	9	*	25.2	95 (soft)
IAC 165	long	slender	-	L	5.4	88 (soft)
IR 47686-6-2-2-1	long	slender	1	HII/I	18.0	90 (soft)
IR 47686-9-2-B	long	slender	9	I	20.0	95 (soft)
IRAT 104	long	slender	5	HI/I	17.6	100 (soft)

varieties, ADT 31 does not possess the desirable physico-chemical traits for the country, therefore the variety has been rejected altogether.

Among the rest of the highest yielding varieties, Niupela was recommended by us for general cultivation as far back as 1992. At the moment Niupela is popular with the farmers, thoroughout the country.

The two new varieties viz. IR 47686-6-2-2-1 & IRAT 104 possess good agro-botanical traits, good milling recovery and desirable physico-chemical traits. Therefore both the varieties are suitable for upland rice cultivation in the country. The most recent consultancy team on the site development studies for rice production has also emphasized the selection of IRAT varieties. Fortunately two out of three new selections are either a derivative (IR 47686-6-2-2-1) or a direct IRAT variety (IRAT 104).

The third new variety IAC 165 is ninety days-maturing and is suitable for progressive farmers, because it has very early vegetative vigour and completes its life cycle (seed to seed) one month earlier than the other varieties. Consequently it requires a greater care by the farmer for early topdressing, weeding and pest scouting etc. In fact this variety is able to escape drought by maturing before severe drought develops.

At Maprik, we have also conducted an observational micro plot trial (planted at Nala area) on IAC 165 and other selections including Niupela. The planting time was mid-year 1993. The very severe drought adversely affected the growth of rest of the genotypes including Niupela, at the panicle initiation stage. While IAC 165 proved its potential by avoiding the severe drought, we could not have any grain from rest of the genotypes. On the contrary we had harvested a good crop of IAC 165 and have used the seed for the experiments conducted during the first quarter of 1994 at ERDC. From this observational trial, we deduced that the variety possesses the mechanism to avoid drought by maturing one month earlier. In fact such a variety has been envisaged most useful for PNG by a consultancy study (Anonymous 1993). The variety may be recommended for late planting.

IAC 165 is really a marvelous plant, because it possesses most of the good attributes of an upland variety. We are envisaging it as the future donor of early maturity, drought tolerance, thick culm, deep and well developed & profuse root system, high test weight etc. It will be a good fit for growing 4 crops a year, under lowland; and two crops a year, under upland field conditions. The variety will also fit in very nicely in the sequential planting's (or relay cropping) of following rotations, for Markham Valley in particular and PNG in general:

Rice (90-days variety) - Nov Dec Jan	Rice (90-days variety), Jan Feb March
Rice (90 days variety) - Nov Dec Jan	Legume (60 days variety) Feb Mar

Unfortunately IAC 165 like other traditional upland rice varieties seems to possess less tillering capacity. But this problem can be overcome by increasing the seed rate. Regarding physico-chemical traits, it possesses very low amylose contents (5%), but cooks as soft as IR 47686-6-2-2-1 & IRAT 104. Therefore, the variety may be recommended as a glutinous variety for the country.

All the three new varieties have the traditional tall plant posture, medium tillering capacity, droopy but very long flag leaves, droopy but well exserted (suitable for hand harvesting) & fully filled panicles with heavier grains. Their foliage remain green up to maturity, the trait very vital for photosynthates translocation (from source to sink) up to late maturity, resulting in the higher yield.

The results of the yield trial at Bereina were very interesting, because we tested Luke-3, a lowland variety, under upland field in comparison to the rest of the entries. The results of the yield trial have proved that Luke-3 is equally good for upland field conditions. Another variety KK 15-36-C (from Nepal) was extremely good for lowland, but from the yield trial conducted at ERDC, it is evident that the variety is not good for upland niche.

CONCLUSION

The varieties IRAT 104, IR 47686-6-2-2-1 & IAC 165 have exhibited their high yield potentials under upland ecosystem, in the yield trials conducted, country wide. They have also surpassed for milling recoveries; and possess very desirable physico-chemical traits. Therefore, it is concluded that the three varieties may be released for general cultivation in the country for upland rice cultivation. IAC 165 has low amylose contents, but cooks soft like those of IRAT 104 & IR 47686-6-2-2-1. Therefore variety IAC 165 may specifically be recommended as glutinous rice for the country.

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Appendix 1: **Most promising selections, suitable for upland ecosystems of Papua New Guinea.**

S.No.	Code name	Experimental name	Designation/origin
1.1	**Ready for release.**		
25	ER 25	RTP-19-91	IAC 165/Brazil
26	ER 26	IRTP-29-91	IR 47686-6-2-2-1/IRRI(IRAT 104/Palawan)IRRI
27	ER 27	IRTP-38-91	IRAT 104 (IRAT 13/Moroberekan)/Ivory Coast
1.2	**Advane stage material.**		
28	ER 28	IRDTN-1-91	Agulha/Brazil
29	ER 29	IRDTN-23-91	IRAT 170/Ivory Coast
30	ER 30	IRDTN-79-91	235D-IRAT/IRAT
31	ER 31	IURON-2-91	BR 4285-5-2/Bengla Desh
32	ER 32	IURON-83-91	IR 55411-53/IRRI
33	ER 33	IURON-84-91	IR 55433-63/IRRI
34	ER 34	IURON-92-91	IR 43/IRRI
1.3	**Elite selections.**		
35	ER 35	IURON-26-93	IR 47686-16-7-1/IRRI
36	ER 36	IURON-27-93	IR 47686-31-1-1/IRRI
37	ER 37	IURON-38-93	Kalaris/Hungary
38	ER 38	IURON-45-93	RP 2235-200-91-62/India
39	ER 39	IURON-53-93	Toxi 1889-4-102-3-2-1/IITA/Nigeria
40	ER 40	IURON-54-93	Toxi 1889-6-102-1-1-2/IITA/Nigeria
41	ER 41	IURON-58-93	Salumpikit/Philippines
42	ER 42	IURON-67-93	CT 8422-8-M-2-3-2-1/CIAT
43	ER 43	IURON-69-93	IRAT 136/Ivory Coast
44	ER 44	IURON-77-93	ITA 301/IITA, Nigeria
45	ER 45	IURON-83-93	PR 36-1-4-1/Zaire
46	ER 46	IURON-85-93	PR 39-1-2/Zaire
47	ER 47	IURON-90-93	Toxi 1791-15-B-4/IITA/Nigeria
48	ER 48	IURON-94-93	Wabis 844/WARDA