Principal Component Analysis (PCA)

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1. Primer paso: cargar las librerias que necesitas.

```
library(ggplot2)
library(dplyr)
library(missMDA) # Imputate
library(ggfortify) # autoplot()
library(cluster) #pam
library(factoextra) #get_pca_var()
library(data.table) # data.table()
library(devtools)
install_github("vqv/ggbiplot") #ggbiplot
library(ggbiplot)
```

2. Segundo paso: cargar los datos.

```
channel <- read.csv("data/channel_form.csv", header=TRUE)
head(channel)
```

```
##      Forma NAN_Am NADBO NAtemp  nit NASatO2 Elevacion Ancho Velocidad Rocas
## 1 Trapecio   0.03  2.38  27.33 0.35   92.04        23    16         5    20
## 2 Trapecio   0.03  2.95  27.81   NA  100.03        31    11         0    20
## 3 Trapecio   0.03  3.13  24.27   NA   96.82        35    14        10    30
## 4 Trapecio   1.15  4.73  27.06 7.54   64.35         9     5         2     0
## 5 Trapecio   0.50  8.16  26.60   NA  110.39        43    11         9    10
## 6 Trapecio   0.53  8.57  23.82   NA  106.09        23    11         5    20
##   Canto grava arena Limo
## 1    25    30    20    0
## 2    45    20    15    0
## 3    30    20    10    0
## 4     0     0    50   50
## 5    40    10    20   20
## 6    60    20     0    0
```

2.1 Vamos a examinar los datos

```
summary(channel)
```

```
##     Forma               NAN_Am           NADBO            NAtemp
##  Length:138         Min.   :0.0200   Min.   : 1.310   Min.   :14.67
```

```
##  Class :character   1st Qu.:0.0400   1st Qu.: 1.930   1st Qu.:24.30
##  Mode  :character   Median :0.2150   Median : 3.000   Median :26.05
##                     Mean   :0.3201   Mean   : 6.164   Mean   :25.84
##                     3rd Qu.:0.5000   3rd Qu.: 8.585   3rd Qu.:27.70
##                     Max.   :1.5000   Max.   :34.900   Max.   :32.18
##                                      NA's   :35
##       nit            NASatO2         Elevacion          Ancho
##  Min.   :  0.00   Min.   : 23.43   Min.   :   3.00   Min.   : 1.000
##  1st Qu.:  0.40   1st Qu.: 86.24   1st Qu.:  25.25   1st Qu.: 2.000
##  Median :  0.92   Median : 94.59   Median :  53.00   Median : 3.000
##  Mean   : 12.00   Mean   : 91.05   Mean   : 230.89   Mean   : 3.822
##  3rd Qu.:  1.62   3rd Qu.:100.52   3rd Qu.: 269.25   3rd Qu.: 3.000
##  Max.   :324.11   Max.   :122.73   Max.   :2370.00   Max.   :16.000
##  NA's   :57                                          NA's   :3
##    Velocidad          Rocas           Canto           grava
##  Min.   : 0.000   Min.   : 0.00   Min.   : 0.00   Min.   : 0.0
##  1st Qu.: 3.000   1st Qu.: 0.00   1st Qu.: 0.00   1st Qu.: 2.5
##  Median :11.000   Median :10.00   Median :25.00   Median :20.0
##  Mean   : 9.133   Mean   :16.25   Mean   :25.65   Mean   :17.8
##  3rd Qu.:14.000   3rd Qu.:30.00   3rd Qu.:40.00   3rd Qu.:25.0
##  Max.   :16.000   Max.   :90.00   Max.   :80.00   Max.   :80.0
##  NA's   :3        NA's   :3       NA's   :4       NA's   :3
##      arena            Limo
##  Min.   :  0.00   Min.   :  0.00
##  1st Qu.: 10.00   1st Qu.:  0.00
##  Median : 15.00   Median : 10.00
##  Mean   : 19.79   Mean   : 20.62
##  3rd Qu.: 25.00   3rd Qu.: 25.00
##  Max.   :100.00   Max.   :100.00
##  NA's   :3        NA's   :3
```

2.1 Remover la(s) variable(s) que tiene(n) mucho(s) NAs y las Etiquetas (a la funcion lo le gusta), luego las agregamos.

```
channel_1 <- select(channel, -Forma, -nit, -NADBO)
summary(channel_1)
```

```
##      NAN_Am           NAtemp         NASatO2         Elevacion
##  Min.   :0.0200   Min.   :14.67   Min.   : 23.43   Min.   :   3.00
##  1st Qu.:0.0400   1st Qu.:24.30   1st Qu.: 86.24   1st Qu.:  25.25
##  Median :0.2150   Median :26.05   Median : 94.59   Median :  53.00
##  Mean   :0.3201   Mean   :25.84   Mean   : 91.05   Mean   : 230.89
##  3rd Qu.:0.5000   3rd Qu.:27.70   3rd Qu.:100.52   3rd Qu.: 269.25
##  Max.   :1.5000   Max.   :32.18   Max.   :122.73   Max.   :2370.00
##
##      Ancho          Velocidad          Rocas           Canto
##  Min.   : 1.000   Min.   : 0.000   Min.   : 0.00   Min.   : 0.00
##  1st Qu.: 2.000   1st Qu.: 3.000   1st Qu.: 0.00   1st Qu.: 0.00
##  Median : 3.000   Median :11.000   Median :10.00   Median :25.00
##  Mean   : 3.822   Mean   : 9.133   Mean   :16.25   Mean   :25.65
##  3rd Qu.: 3.000   3rd Qu.:14.000   3rd Qu.:30.00   3rd Qu.:40.00
##  Max.   :16.000   Max.   :16.000   Max.   :90.00   Max.   :80.00
##  NA's   :3        NA's   :3        NA's   :3       NA's   :4
```

```
##      grava           arena             Limo
##  Min.   : 0.0   Min.   :  0.00   Min.   :  0.00
##  1st Qu.: 2.5   1st Qu.: 10.00   1st Qu.:  0.00
##  Median :20.0   Median : 15.00   Median : 10.00
##  Mean   :17.8   Mean   : 19.79   Mean   : 20.62
##  3rd Qu.:25.0   3rd Qu.: 25.00   3rd Qu.: 25.00
##  Max.   :80.0   Max.   :100.00   Max.   :100.00
##  NA's   :3      NA's   :3        NA's   :3
```

2.2 Vamos a imputar datos. Esto es comun para set de datos de campo, los cuales tienden a tener ceros (por mal funcionamiento de los equipos, condiciones climticas adversas que no puedemos ir al campo). Se realiza como un paso preliminar para para realizar un PCA en un set de datos completos.

Mas informacion aca: https://www.rdocumentation.org/packages/missMDA/versions/1.18/topics/imputePCA

```
channel_2 <- imputePCA(channel_1, ncp=2, scale = TRUE, method = c("Regularized","EM"),
                       row.w = NULL, ind.sup=NULL,quanti.sup=NULL,quali.sup=NULL,
                       coeff.ridge = 1, threshold = 1e-06, seed = NULL, nb.init = 1,
                       maxiter = 1000)

# class(channel_2)
# as.data.frame(channel_2)
```

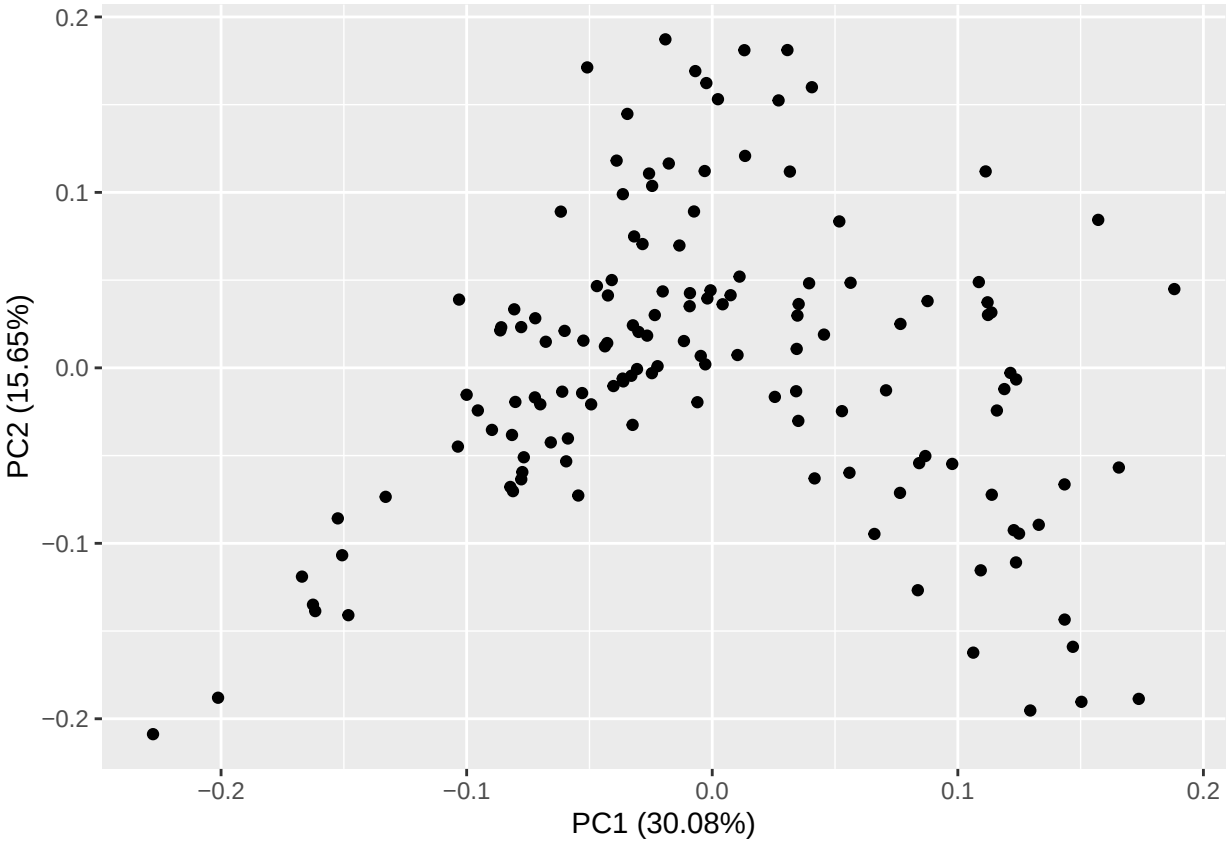
3. Vamos a correr el PCA

```
channel.pca <- prcomp(channel_2$completeObs, center = TRUE, scale = TRUE)
summary(channel.pca)
```

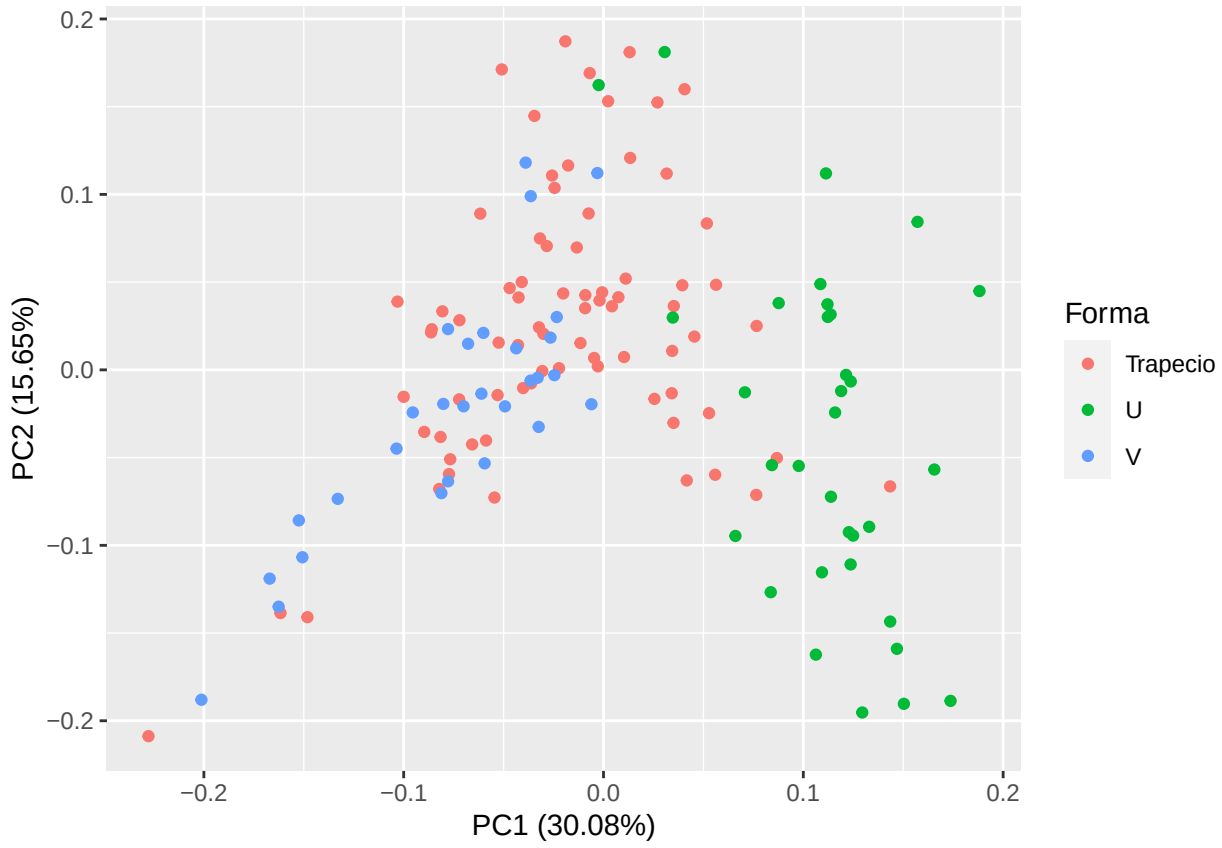
```
## Importance of components:
##                           PC1    PC2    PC3    PC4     PC5     PC6     PC7
## Standard deviation     1.8192 1.3122 1.1975 1.1185 1.00559 0.87738 0.75302
## Proportion of Variance 0.3009 0.1565 0.1304 0.1137 0.09193 0.06998 0.05155
## Cumulative Proportion  0.3009 0.4574 0.5878 0.7015 0.79343 0.86341 0.91496
##                           PC8     PC9    PC10    PC11
## Standard deviation     0.6667 0.59031 0.36992 0.07547
## Proportion of Variance 0.0404 0.03168 0.01244 0.00052
## Cumulative Proportion  0.9554 0.98704 0.99948 1.00000
```

3.1 Vamos a ver el grafico.

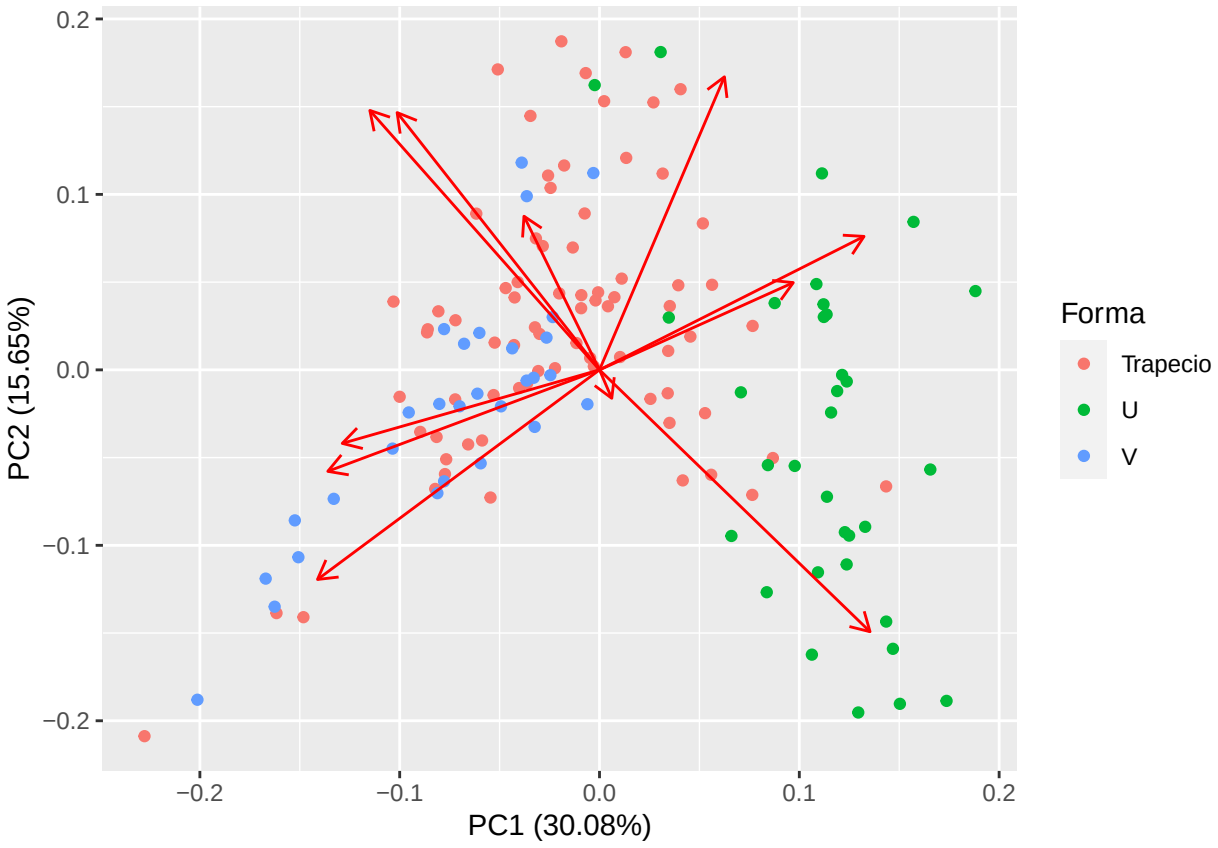
```
autoplot(channel.pca)
```



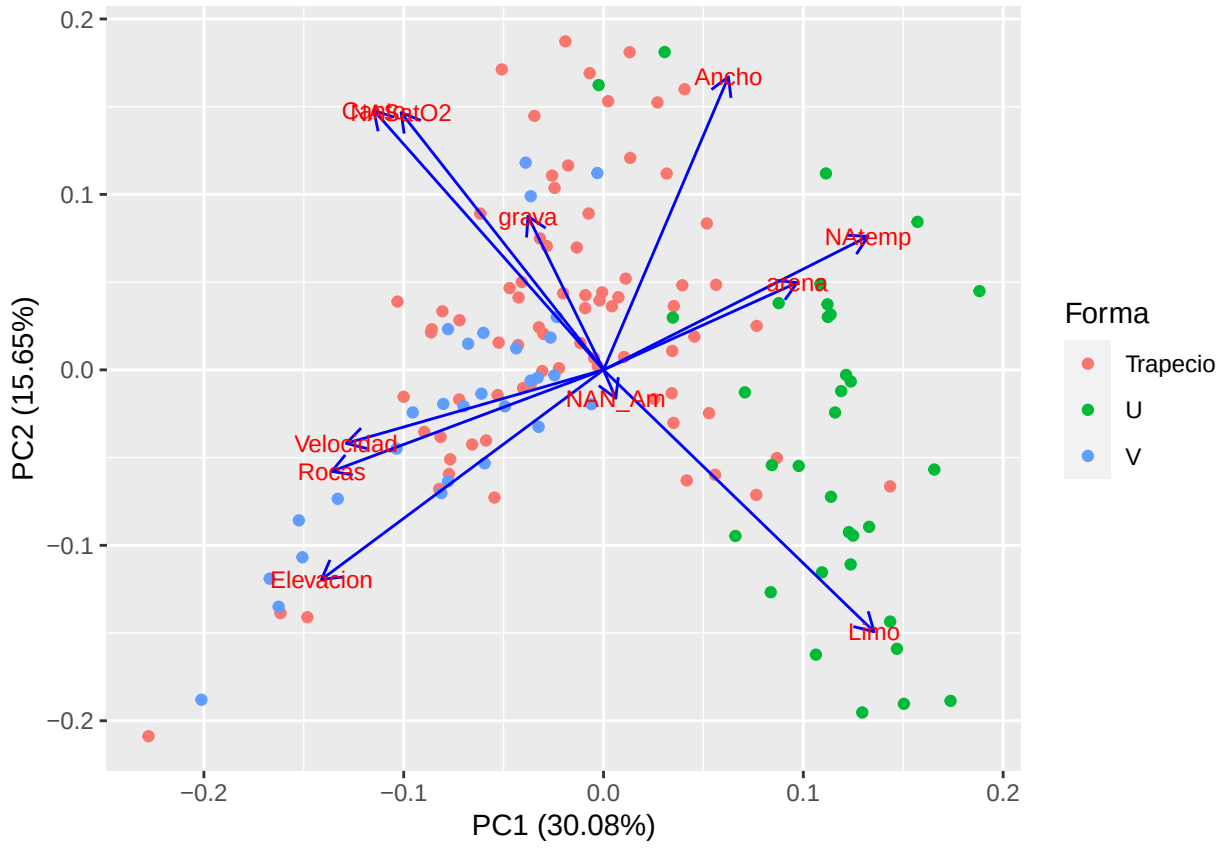

```
autoplot(channel.pca, data = channel, colour = 'Forma')
```




```
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE)
```

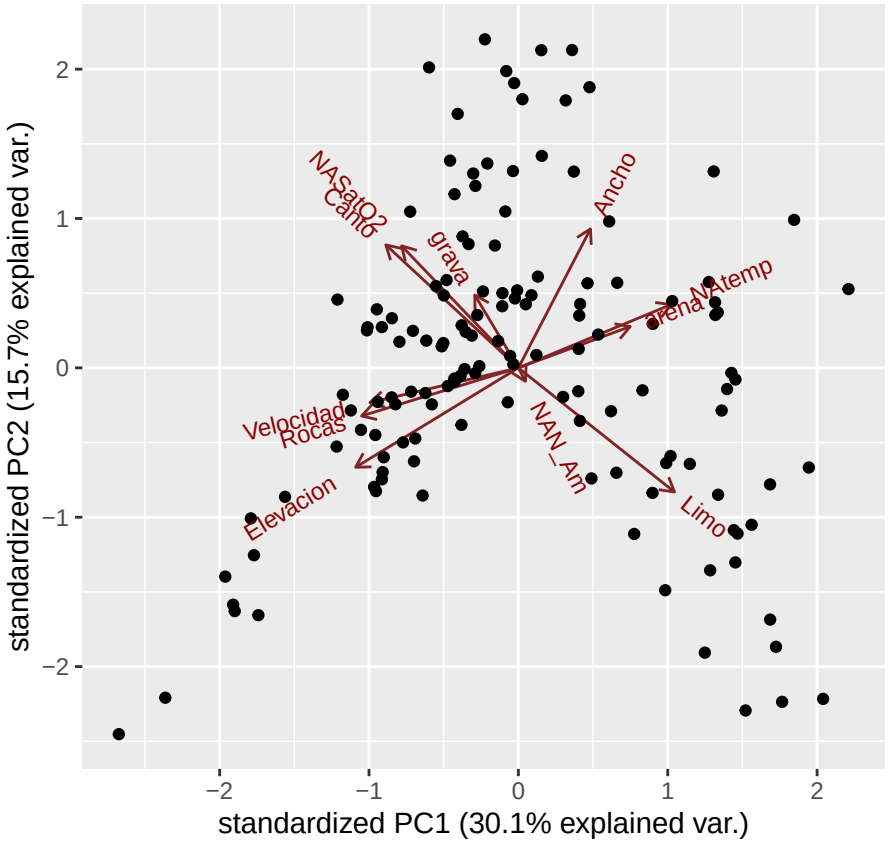



```
autoplot(channel.pca, data = channel, colour = 'Forma', loadings = TRUE,
         loadings.colour = 'blue',
         loadings.label = TRUE, loadings.label.size = 3)
```



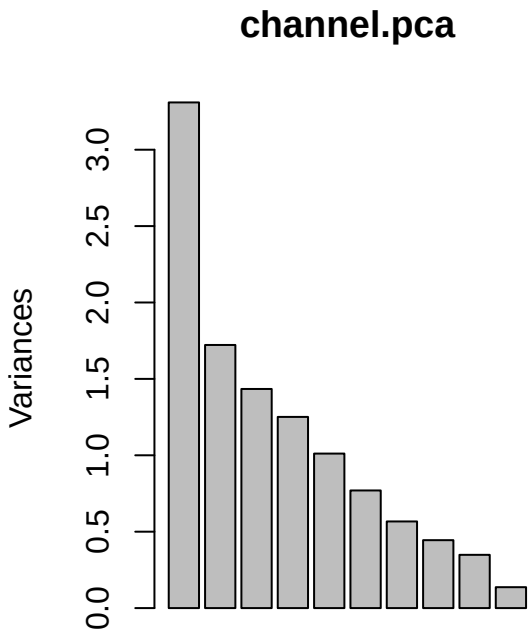
Otra manera de ver el grafico

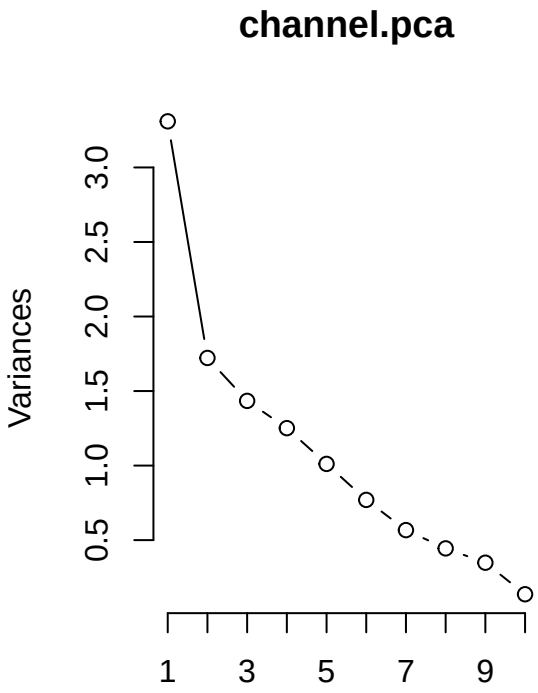
```
ggbiplot(channel.pca, labels=rownames(channel$Forma))
```



3.2 Ver graficamente lo que explica cada axis.

```
layout(matrix(1:2, ncol=2))
screeplot(channel.pca)
screeplot(channel.pca, type="lines")
```





3.3 Vamos a ver la contribucion de cada una de las variables. Usamos otra libreria. factoextra

```
get_eigenvalue(channel.pca)
```

```
##          eigenvalue variance.percent cumulative.variance.percent
## Dim.1  3.309339880      30.08490800                     30.08491
## Dim.2  1.721987545      15.65443223                     45.73934
## Dim.3  1.434048849      13.03680772                     58.77615
## Dim.4  1.251144650      11.37404227                     70.15019
## Dim.5  1.011205837       9.19278033                     79.34297
## Dim.6  0.769787383       6.99806712                     86.34104
## Dim.7  0.567041778       5.15492525                     91.49596
## Dim.8  0.444432998       4.04029998                     95.53626
## Dim.9  0.348471304       3.16792094                     98.70418
## Dim.10 0.136844213       1.24403830                     99.94822
## Dim.11 0.005695562       0.05177784                    100.00000
```

```
res.var <- get_pca_var(channel.pca)
res.var$contrib        # Contributions to the PCs
```

```
##                 Dim.1      Dim.2      Dim.3      Dim.4      Dim.5     Dim.6
## NAN_Am      0.02920886  0.2034616  5.8056413 31.9945477 34.3470814 15.246039
## NAtemp     13.57660503  4.4828567 15.4148551  3.7395130  2.1197838 14.516177
## NASatO2     7.94579553 16.6572006  0.4379407  8.8574581  5.4079970  2.598790
## Elevacion 15.42979758 11.0563517  5.5445224  4.1639816  0.9325291  9.624475
```

```
## Ancho      3.02902190 21.6083873 22.1140351  0.4570409  1.2134531  2.713345
## Velocidad 12.83990263  1.3599088 14.2241968  2.7802734  1.6200790  4.161196
## Rocas     14.32470621  2.5906170  2.5662488  3.2825439  1.7671606 29.965671
## Canto     10.23186117 16.9344566  0.2986754  4.7329896 12.2604278  5.124245
## grava      1.10633855  5.9387801 30.8293418 16.2613832  0.3136215  9.937735
## arena      7.28689335  1.9159508  2.4783815 18.4552620 33.9916827  3.692205
## Limo      14.19986918 17.2520289  0.2861611  5.2750067  6.0261840  2.420122
##                  Dim.7       Dim.8        Dim.9      Dim.10       Dim.11
## NAN_Am     0.01132441  5.69938420 6.040932e+00  0.62044106  0.001939282
## NAtemp     0.73662346  0.59088977 2.080669e+00 42.69918930  0.042838114
## NASatO2    1.24823008 55.62178693 1.180103e+00  0.02000417  0.024693645
## Elevacion  0.24607958  0.96539511 3.314342e+00 48.68500085  0.037525452
## Ancho      5.68811760  0.01494364 3.793491e+01  5.22569343  0.001047357
## Velocidad 21.91572939  0.18791971 3.942194e+01  1.46336747  0.025485968
## Rocas     23.07674466  4.13345827 1.324401e+00  0.08968473 16.878763447
## Canto     11.02914223 12.77009548 6.399584e+00  0.08647903 20.132043196
## grava     21.59705383  2.73504867 2.422399e-04  0.47831503 10.802140459
## arena     13.91693263  1.00150996 6.374613e-01  0.55983412 16.063886205
## Limo       0.53402214 16.27956826 1.665410e+00  0.07199080 35.989636876
```

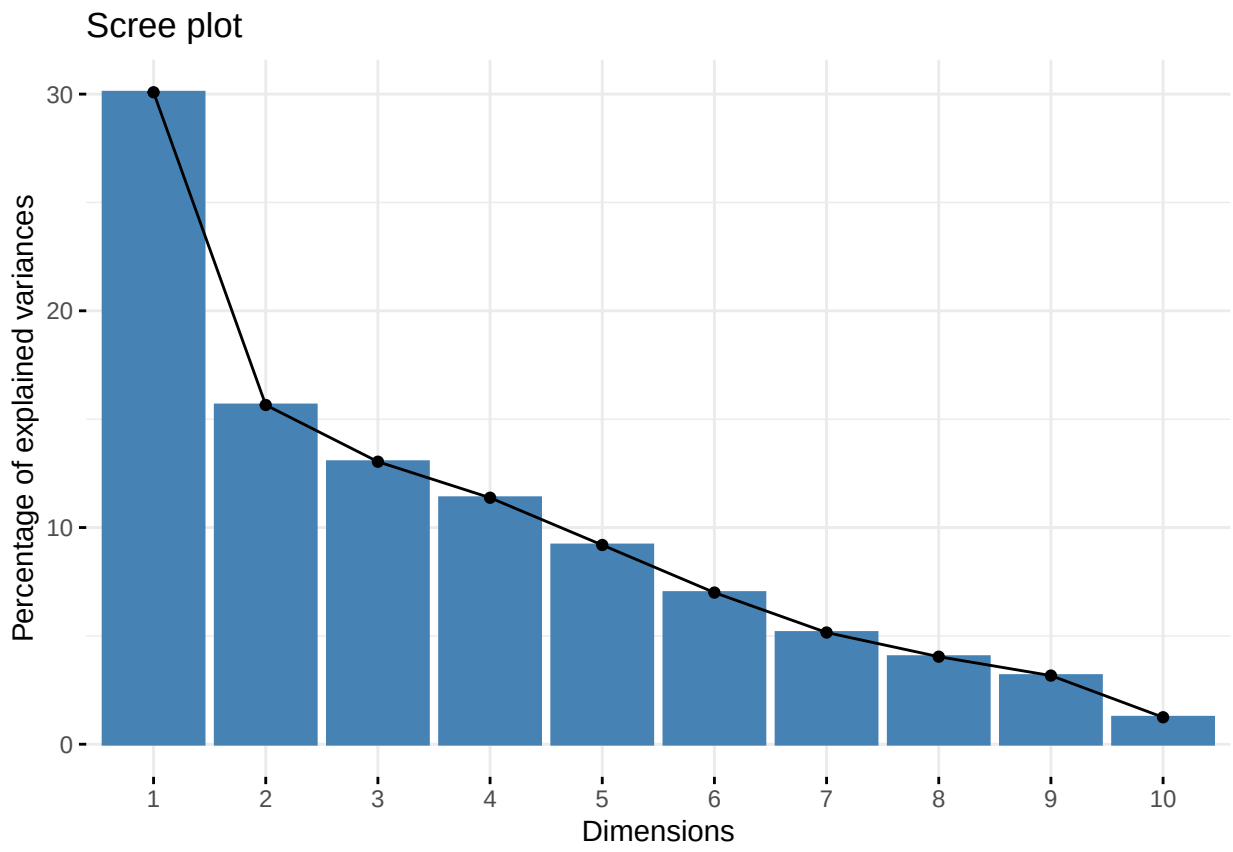
```
res.var$coord          # Coordinates
```

```
##                Dim.1       Dim.2       Dim.3       Dim.4       Dim.5
## NAN_Am     0.03109052 -0.05919107 -0.28854069 -0.63269113  0.58933835
## NAtemp     0.67029546  0.27783850 -0.47016652 -0.21630237 -0.14640826
## NASatO2   -0.51278980  0.53556971  0.07924824 -0.33289580  0.23385034
## Elevacion -0.71457991 -0.43633588  0.28197723  0.22824862  0.09710710
## Ancho      0.31660801  0.60999487  0.56313947  0.07561906 -0.11077233
## Velocidad -0.65185583 -0.15302764 -0.45164359  0.18650802 -0.12799349
## Rocas     -0.68851523 -0.21121104  0.19183655 -0.20265580  0.13367734
## Canto     -0.58189953  0.54000855  0.06544578 -0.24334450 -0.35210533
## grava     -0.19134394  0.31978908 -0.66491189  0.45105812  0.05631482
## arena      0.49106829  0.18163820  0.18852374  0.48052266  0.58628140
## Limo       0.68550852 -0.54504843  0.06406005 -0.25690069 -0.24685446
##                Dim.6        Dim.7        Dim.8         Dim.9       Dim.10
## NAN_Am     0.3425815 -0.008013373  0.159153838 -0.1450893281 -0.029138251
## NAtemp    -0.3342809  0.064629426  0.051245576  0.0851500600 -0.241725815
## NASatO2   -0.1414396 -0.084130767 -0.497193700  0.0641273732 -0.005232070
## Elevacion  0.2721911  0.037354705 -0.065502171  0.1074687420 -0.258113553
## Ancho      0.1445233  0.179593995  0.008149508 -0.3635825795 -0.084563935
## Velocidad -0.1789759 -0.352521406 -0.028899433 -0.3706401926 -0.044749678
## Rocas     -0.4802832  0.361738556  0.135537643 -0.0679349618  0.011078283
## Canto      0.1986097 -0.250079676  0.238232068  0.1493342367 -0.010878490
## grava      0.2765853  0.349949022 -0.110251797  0.0009187691  0.025584105
## arena     -0.1685886 -0.280917821  0.066716120  0.0471314081 -0.027678522
## Limo       0.1364910 -0.055028435 -0.268982849 -0.0761805491 -0.009925485
##                Dim.11
## NAN_Am     0.0003323447
## NAtemp    -0.0015620088
## NASatO2   -0.0011859350
## Elevacion -0.0014619458
## Ancho      0.0002442393
## Velocidad  0.0012048108
## Rocas      0.0310054912
```

```
## Canto       0.0338619707
## grava       0.0248040851
## arena       0.0302477874
## Limo        0.0452748515
```

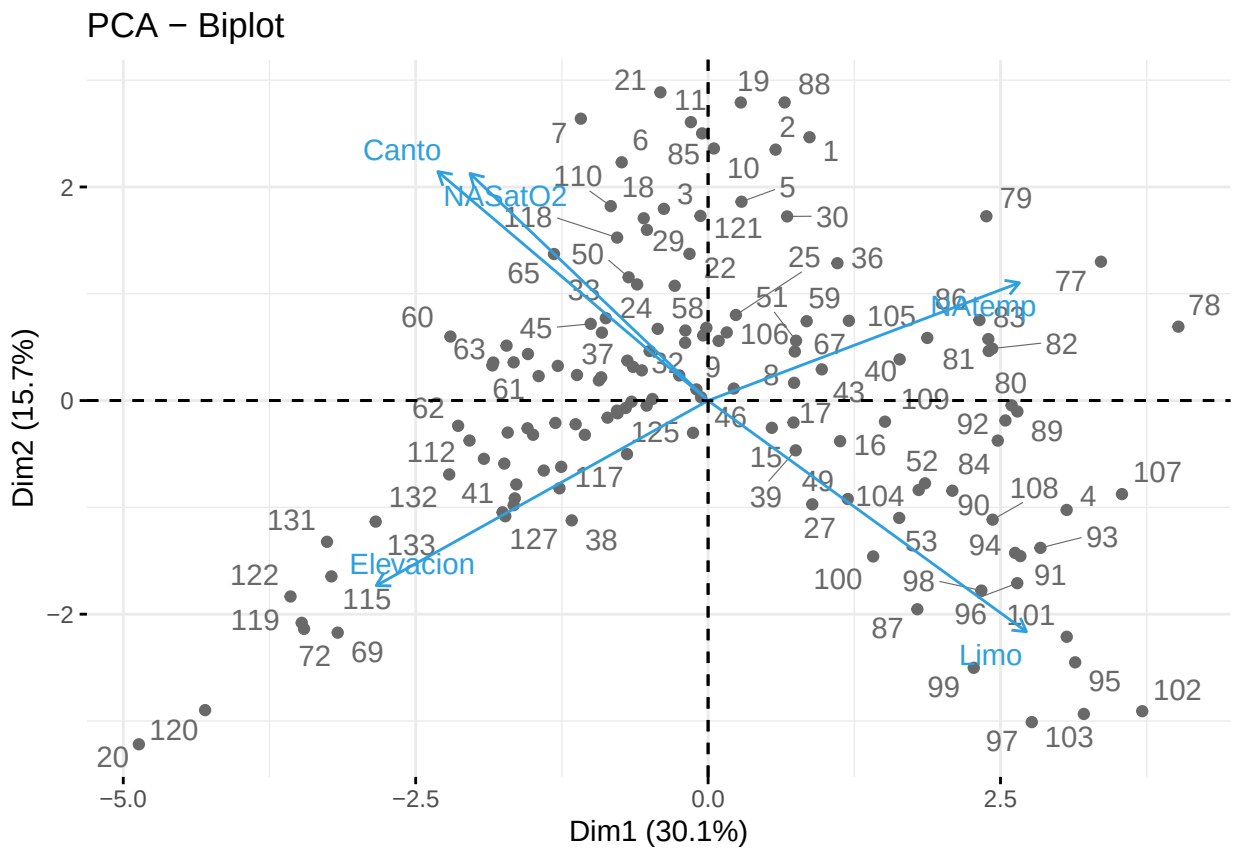
4 Otras formas de visualizar los datos.

```
fviz_eig(channel.pca)
```



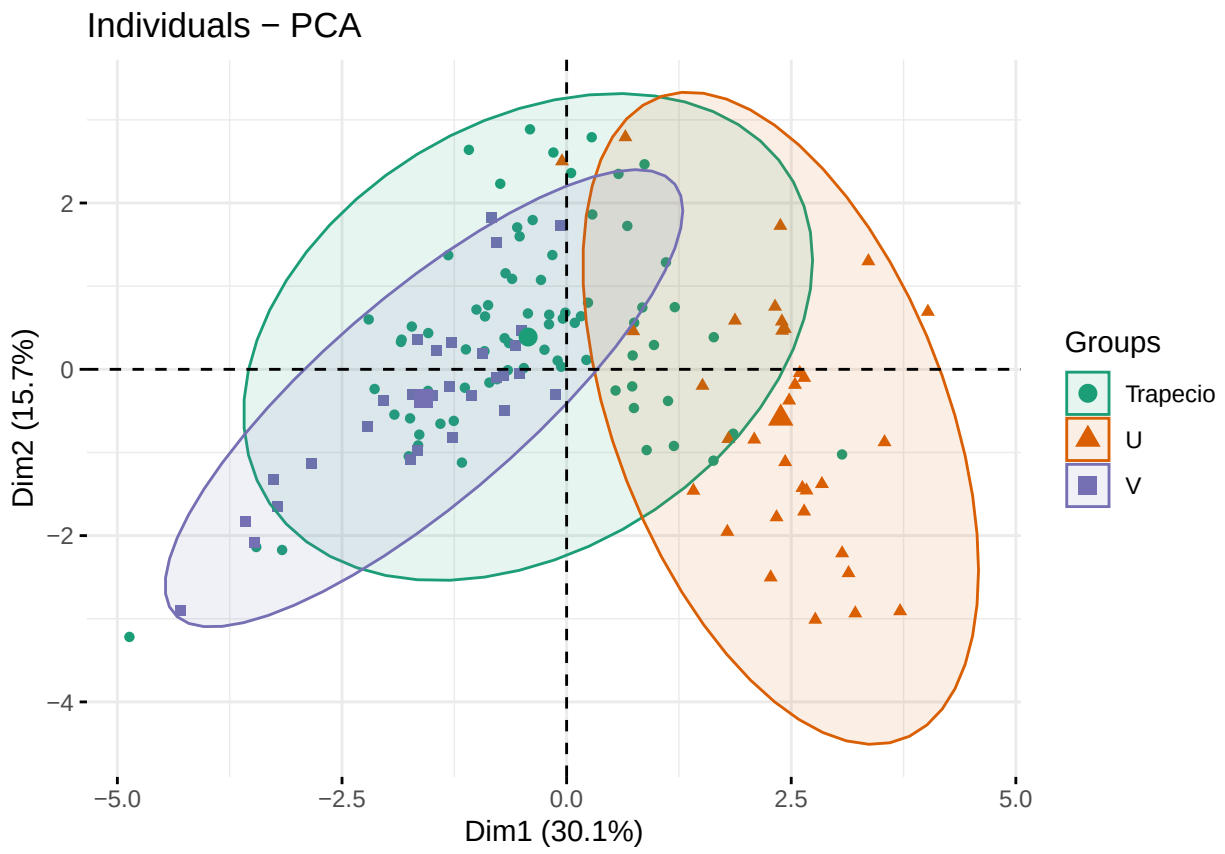

```
fviz_pca_biplot(channel.pca, repel = TRUE,
                col.var = "#2E9FDF", # Variables color
                col.ind = "#696969",  # Individuals color
                select.var = list(contrib = 5))
```

```
## Warning: ggrepel: 41 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



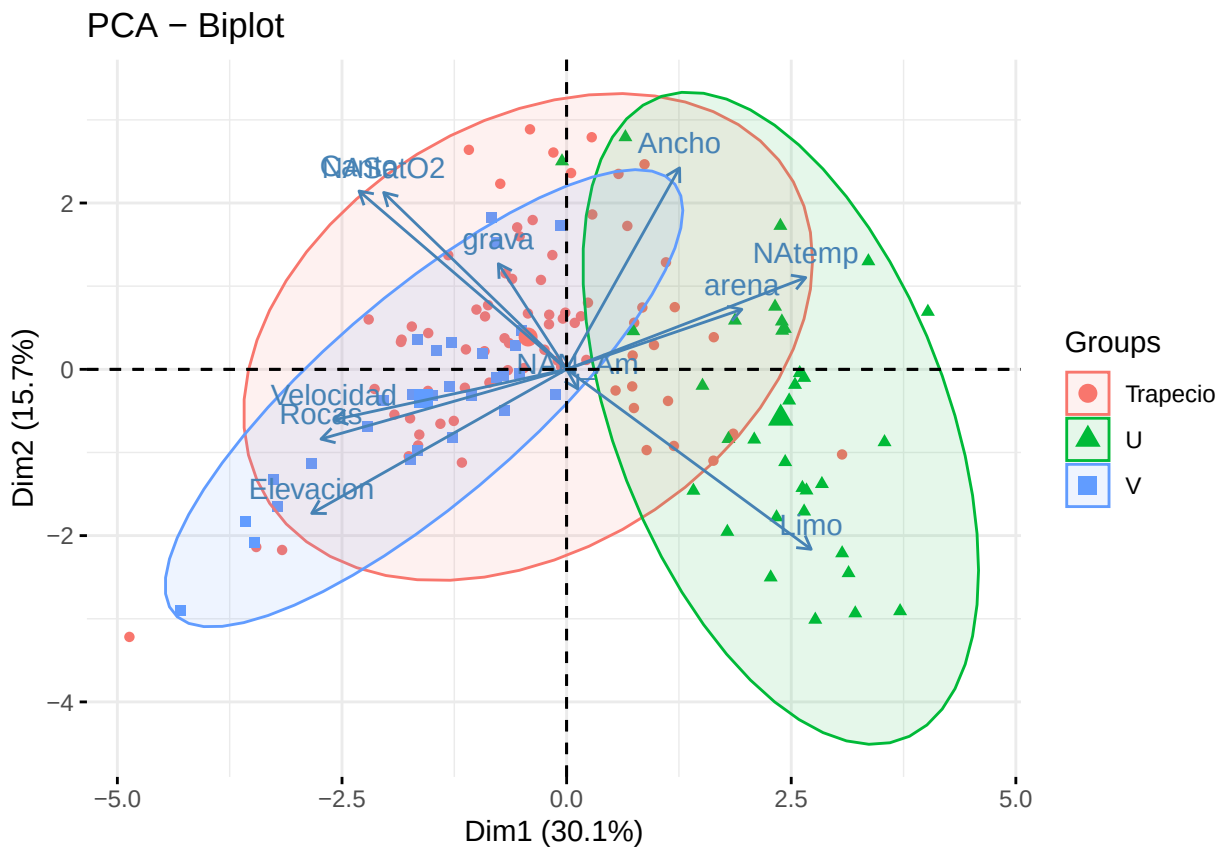
4.1 Con las elipses.

```
fviz_pca_ind(channel.pca, label="none", habillage=channel$Forma,
     addEllipses=TRUE, ellipse.level=0.95, palette = "Dark2")
```



4.1

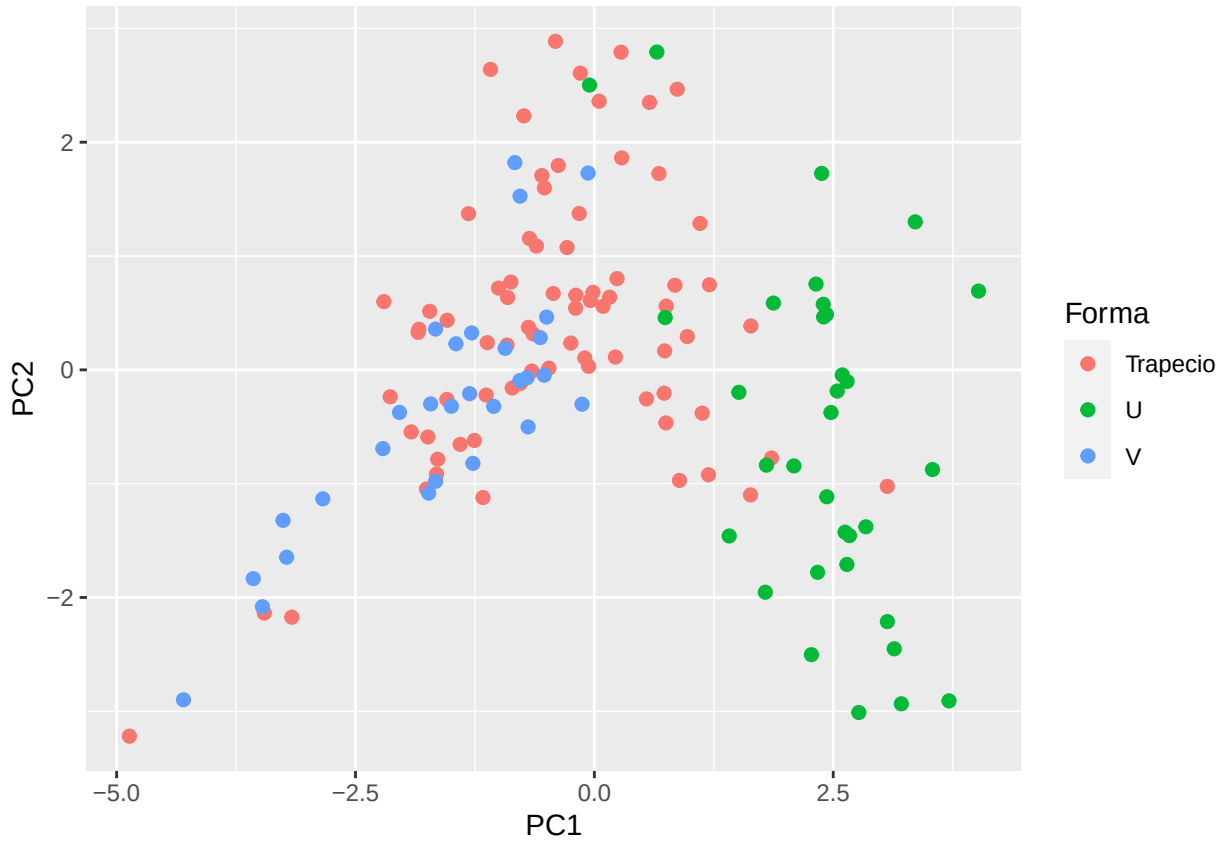
```
fviz_pca_biplot(channel.pca, label = "var", habillage=channel$Forma,
                addEllipses=TRUE, ellipse.level=0.95,
                ggtheme = theme_minimal())
```



5. Convertirlo en una data.frame para trabajarlo en ggplot2

```
data <- data.table(PC1=channel.pca$x[,1], PC2=channel.pca$x[,2], Forma=  channel[,1])
data <- data[order(channel$Forma),]

ggplot(data, aes(x=PC1,y=PC2)) +
  geom_point(size = 2, aes(color=Forma))
```


2
0
−2
PC2
−5.0
−2.5
0.0
2.5
PC1
Forma
Trapecio
U
V