GIS APPLICATION FOR AGRICULTURAL COMMODITIES SUPPLY MONITORING IN VIETNAM: THE CASE OF COFFEE

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ABSTRACT

Vietnam is traditionally agricultural country. Over the last decade, Vietnam has gained remarkable achievements, becoming a leading agricultural exporter in the world. However, it is still a poor country with low GDP per capita, partly due to the inability of Vietnam to control production of main export agricultural products, especially facing with great fluctuation in the world market like the case of coffee.

Even though Vietnam has several crop information sources, the statistical method is not scientific and unified, leading to the failure to have exact information. According to various studies, no body/agency inside and outside Vietnam can be sure of the credibility of the information collected. This poses great difficulties for farmers and other stakeholders in the value chain to have effective and timely investment and production adjustment.

An advanced and science-based technique to collect credible crop information is therefore very important for policy analysis and recommendation and better crop management of farmers and other stakeholders.

Since 2004, the French NGO AIRECTS works closely with the Institute for policies and strategies for agriculture and rural development (ISPARD) to design a permanent and reliable crop monitoring solution. The outputs of this analysis are acreage of all crops in the surveyed area including coffee, acreage and yield of coffee in the whole area and roughly potential output of coffee area. The sample of farmers is drawn from the coffee fields population constituted within the acreage survey.

The first time of trial was conducted in Dak Lak for coffee. The result shows that in 2005, coffee area reduced by 14,5% compared to 2001, in which, mature coffee area declined by 12,6% and young coffee area was down by 8,4%. Rice area was also measured with the decline tendency in the same period of 9% and while the forestry figure was around 8%.

Coffee yield also varied so much from 0.8 tons/ha to over 3,5 tons/ha. Average coffee yield was around 0.96 tons/ha in 2005, 0.13 tấn/ha lower than that of 2001, mainly due to prolonged dry weather in 2005. Lower acreage and yield led to the much decreased coffee output in 2005, by 24%, to only 239.876 ha. Data collected from this methodology is far different from the official data from GSO and MARD. In 2005, coffee area given by DARD-Dak Lak was 32.5% lower than the current data, while the difference in total output was only 7.3%. This shows that the current statistics data have some problem in their accuracy that needs further varification and testing.

1. INTRODUCTION

In 1998, Viet Nam was the second biggest Robusta coffee exporter in the world. Since then, the country has continuously the important export partner in the world market, making great contribution to the country export earning, providing jobs and partly contributing to poverty reduction of many stake holders in the commodity chain, especially farmers and small traders. This has stimulated farmers in other areas in Vietnam rushing to coffee plantation, abruptly increasing coffee acreage. Coffee export from Vietnam (accounting for 14% of the world market), has then had big impact on the world price fluctuation. In the coffee crisis since 1998, Vietnam has been blamed by many countries to be over surplus, unbalance the world market, depressing coffee prices, jeopardizing lives of not only Vietnamese farmers but also farmers over the world, especially the poor and ethnic

In addition, due to the shortage of information on production cost, Vietnam coffee farmers have not knowledge on their competitive advantage in the region as well as in the world. Whereas, information provided by the government has untimely accessed and has lacked forecast and analysed information for farmers and enterprises to make effective decisions. Therefore, an advanced techniques to collect information on supply side of agricultural commodities, especially such an important commodity as coffee is of great need, not only for the state management but also for farmers and other stakeholders along the commodity chain.

2 CURRENT DATA SOURCES ABOUT COFFEE SUPPLY IN VIETNAM

At present, there are some agencies who provide statistic data on supply of agricultural commodities in Vietnam, among which the agencies providing information on coffee supply are General Statistic Office (GSO), VICOFA, Ministry of Trade, Customs General Department, Department of Agriculture and Rural Development in Daklak...However, there are a big difference among these statistics. GSO collects information about acreage, productivity, production from the statistic reports of provinces and agriculture census. This census collected information from questionaires for farm households. VICOFA estimates the coffee supply of at the beginning of the crop based on the previous year data of provinces and experts' experiences. At the end of the crop, the production equals to the previous and this year stock minus temporary re-export and domestic consumption data and plus the export data. Department of Agriculture and Rural Development in Daklak based on the data of the Department of land. Other domestic and foreign enterprises use different questionaires and private, irregular sources of information. With such inconsistent data collection methods, the data given from these agencies are different and impossible to measure the difference.

In 2005, the project "Information capacity building for agriculture policy formulation" (MISPA) supported by the French Foreign Affairs has assisted the Institute of Policy and Strategy for Agriculture and Rural Development to apply the method for coffee supply estimation by GIS and sattelite images successfully. This method has been applied in many European, American countries (especially in Brazil) and China (for 9 important agricultural commodities nation wide)

The results have shown that the application ability is satisfactory, highly precise, not so costly, not only for coffee but also for other perenial crops.

3. COFFEE SUPPLY ESTIMATES BASED ON SATELLITE IMAGES AND GIS TECHNOLOGY

ASF applied in the world and advantages of satellite images

Area sampling frame is an supply information collection method born since middle 1940s. Principle of this method is to divide the whole area into smaller pieces by geographical borders such as roads, rivers or others. Those prices can be small (with the acreage of less than 1 mile square) or big (over 10 miles square), depending on the statistical precision requirement. Pieces chosen into the sample must represent the characteristics of the whole area with the acceptable precision. Afterthat, a number of pieces will be randomly selected for ground measuring.

In the decade of 1970, the invention on colour sattelite image has been discovered. Sattelite image was captured digitally, based on the criteria of light reflected from ground. The image can cover a big area(even the whole country or production regions) with low ost and short time period. Agricultural researchers have started to explore the potential of these images to differentiate crop seasons, measure acreage and assess the growth conditions of crops. However, the distinction of different crops based only on sattelite emage is not feasible since it is too hard to see the difference just from the image.

A very important application of sattelite image is the "stratification" of an area by strata with similar criteria, help to minimize the differences in the area. Recently, Landsat or Spot images have special characteristics to help effective stratification. USDA has combined these advantages of sattelite image with AFS. Sattelite image has no sampling errors as the image cover the whole region. However, looking down from the sattelite, crops look very similar. So, the ability of stratification by image can be well combined with ASF to minimize the erros.

The method is described as follows:

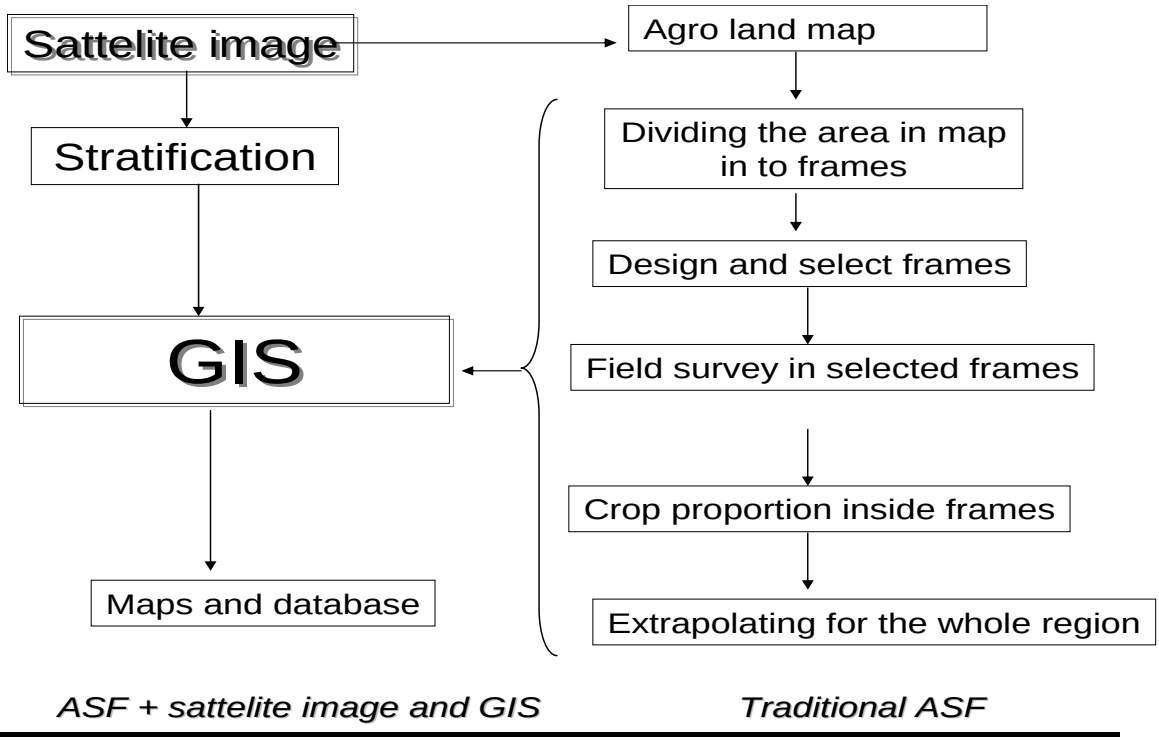

Figure 1. ASF methodology

At present, AFS method combined with satellite images has been applied in many countries for agricultural supply estimation like Europe(France, Findland, Italia, Rumania and Bulgaria), Latin America (Brazil, Argentina), Africa (Cote D'Ivoire, Ghana, Mali) and Asia.

Especially, China has applied this method for 7 kinds of crops in 9 provinces since 1998. Inputs used by China are agricultural map with the scale of 1:100000 and Landsat. After the period of image analysis, stratification, China applied AFS method to measure the acreage, using GPS and video camera in each segment of 4km*4km. With the area of segments selected, statistic analysis has been applied to calculate the area for each crop in each province and district. The graph nearby describes the survey procedures of supply of some agricultural commodities in China. This method has the advantages such as: (i) appropriate with the current status of agricultural sector in Vietnam, including multi season, fragmentation, multi crops; (ii) high precision (97%); (iii) provision of annual data on acrage, production and crop structure. However, the application of this method has faced a number of difficulties like requiring many kinds of maps (land, water, ecology... for stratification). So the application of this method should be adapted in Vietnam.

Application of AFS in Vietnam

Being aware of advantages of this method, expert group from France, Spain and USDA has worked together to develop this technology for coffee in Vietnam since 1998. In 2005, French experts assisted IPSARD to apply this method for coffee in Dak Lak.

The expert group used Landsat, based on value in each pixel to categorize Đak Lak province into 15-20 groups. After discussing with experts, refering to secondary data and maps, and primary survey in selected areas, the research groups gave names for each group. And then, the stratification can be conducted by digitizing borders for each stratum.

Number of segments fro acreage survey will then be identified based on fund availability, optimal number of segments and CV (coefficient of variation) of less then 10%. Optimal number of segments will be set by multiply the area of strata with 0.3-0.75%, and then take the whole area divided by the area of segments. Segments can be evenly distributed to strata by AFS-tools and by different replica.

Forest
Water
Urban
Natural veget
Medium density
High density
Agriculture
Low density

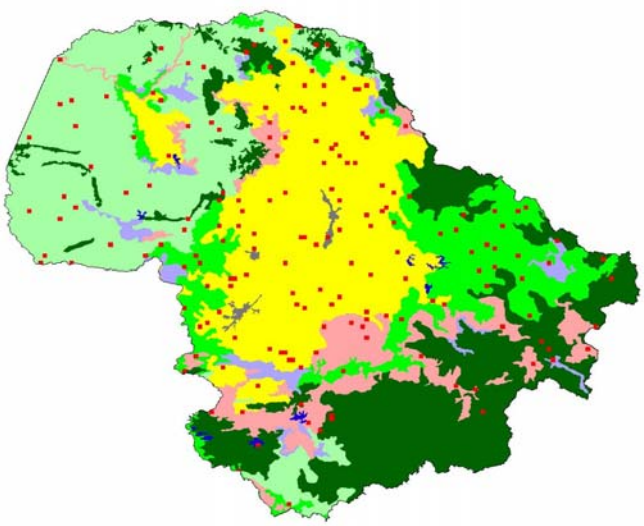

Figure 2. Daklak map divided by 8 strata based on satellite image

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After collecting acreage data, coffee segments will be divided into 4 groups: mixed mature coffee, pure mature coffee, mixed young coffee and pure young coffee. Total number of segments for yield survey should be only equal to 25% of the total number of coffee segments. In each segment to be surveyed, 2 polygons will be chosen based on the orders given by computers.

Based on acreage and yield data, the research group applied statistical analysis method to calculate total area and average yield for each strata and the whole provice as well as give out forecast on acreage, yield and production in 5-10 years based on data collected from the survey only.

4. SURVEY AND ANALYSIS RESULT

Acreage survey

As mentioned above, this method has been applied by French, Spanish and USDA expert group to estimate coffee acreage in 7 main plantation areas in Vietnam, including Daklak. So in this part, data from 2001 can be compared to the data collected in 2005 by IPSARD.

Total area of Daklak calculated by satellite image is around 1.3 million ha, divided into 8 strata, in which agricultural strata accounted for the highest rate of 27%, forest and natural vegetation strata each made up 23%, area of water surface and urban was not remarkable.

Coffee concentrated in agricultural strata. In this strata, coffee area ranged from 20000 ha to 200.000 ha, while coffee area in other strata like forest and natural vegetation was in the smaller range of 10000 ha - 20000 ha.

Coffee density was calculated by taking total coffee acreage divided by total acreage of the strata. The change in coffee density was observed from 2001 to 2005. The map shows that in 2001, coffee density was much higher than that of 2005. In 2005, coffee area reduced by around 14.5% compared to 2001, in which, mature coffee area declined by 12.6% and that of young coffee was down by 8,4% with the CV of mature coffee of around 6%. Whereas, rice area in surveyed site increased by 9% from 2001 to 2005, with the CV of 11% and forestry acreage was down by 50000 ha, equivalent to the reduction of 8%.

Yield survey result

According to the surveyed result, coffee yield had the tendency of increasing along with the higher age of coffee up to when the tree is 15 years old and is likely reduced.

Coffee yield fluctuated much by different regions, from 0.8 ton/ha to over 3.5 ton/ha. However, average coffee yield was only 0.96 ton/ha in 2005, 0.13 ton/ha lower than that of 2001, mainly due to the prolonged draught in 2005, especially when the trees were flowering.

Lower acreage and yield led to the reduction of total coffee production in 2005 in by nearly 24%, to only 239.876 tons.

The data collected from this survey were much different from official statistics of GSO and MARD. , Coffee plantation area in 2001 according to MARD was 34% lower than the data from this survey while the production was nearly the same between the two sources.

Similarly, in 2005, coffee plantation area according to DARD in Daklak was 32.5% lower than that of the data provided by IPSARD while coffee output data collected by the survey was about 7.3% lower that that of DARD.

Coffee yield calculated by this survey was also much different from data from VICOFA ad GSO.

This shows that there might be some problems with the official statistical data of Vietnam due to high variation. This needs to be tested and requires an unified and scientific method for information collection.

Study results show that impact of yield to the total production was bigger than the influence of acreage. Production variation between 2001 and 2005 was around 24%, of them contribution from yield to the difference was about 12% and that from acreage was 13%. This means that averagely, coffee area reduced by over 3% annually while from 2001 to 2005, yield variation was 12%. It can be concluded here that yield variation was much higher than acreage difference.

The study also made some forecast based on data collected from the survey until 2020, including coffee age, yield and acreage of coffee in 2001 and 2005, other factors are provided constant. According to the survey result, coffee yield reduced from 1.09 ton/ha in 2001 to 0.96 ton/ha in 2005 due to fluctuation in the world market reducing investment from farmers and the draught weather. Up to 2010, coffee yield is forecasted to increase a little bit to the same level of 2001 due to the higher coffee age, helpding increase mature coffee area. The yield will continuously increase up to 2015, still thanks to the improvement in crop age. However, since 2010, the yield will gradually reduce and to the level of 1.08 ton/ha in 2020.

In addition, the study also presented different scenario to project total coffee production up to 2020 based on fluctuation in yield, acreage and tree age. The following assumptions were presented as follows:

- Each year, acreage reduced by 3%
- The calculation method of yield based on crop age is applied
- Scenarios to change yield
  - Scenario 1: Yield of 2001
  - Scenario 2: Yield of 2005
  - Scenario 3: Yield of 2001 increases by 10%
  - Scenario 4: Yield of 2005 reduced by 5%
  - Other factors are constant

Projection results are presented in the below table. Total coffee production reduced from 2005 to 2020. Among those 4 scenarios, coffee output was highest in the scenario 3. In 2010, coffee area was nearly equal to the level of 2005 and only much higher than that in the scenario 3. In năm 2015, only in the scenario 3, coffee output was a little bit higher than 2005. In other scenarios, output was much lower than that of 2005, especially in the scenario 4. In

2020, coffee production continued to reduce, even by 30% in scenarios 2 and 4. In generaly, if we only based on variation in tree age structure, acreage and yield, the total production of coffee in Vietnam is likely to reduce in the next 15 years.

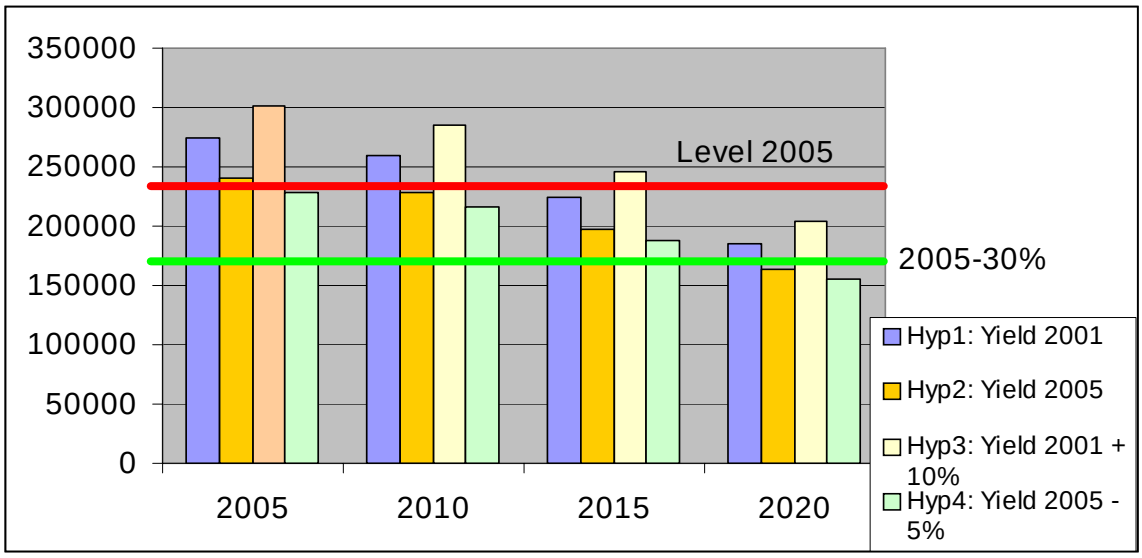

Figure 3. Coffee production forecast in various scenarios (000 tons)

5. CONCLUSION AND RECOMMENDATIONS

The study results show that Robusta coffee yield in Dak Lak was very low in 2005 (0.96 ton/ha), 0.13 ton/ha lower than 2001, mainly due to serious draught and limited invesment of farmers. Yield fluctuation was bigger that that of acreage in the survey year and at least 4-5 coming years. Therefore, frequent survey of yield is very important to monitor the change in total coffee production.

According to the plan to reduce coffee plantation area in Đắk Lắk and MARD, this survey can recommends the low yielding area that could be declied, mainly in the strata of high vegetation shrub and natual vegetation. However, lower acreage should go parallely with increased coffee yield, coffee should be newly planted to replace old trees.

The survey also revealed the big difference in acreage and yield data between official statistic sources and the IPSARD survey. Especially, the acreage difference between IPSARD and MARD sources was up to 34% and and 32.5% in 2001 and 2005 respectively. This shows that there might be some problems with the official statistic data of Vietnam.

This requires the development and application of a scientific method for supply data collection with high feasibility. And the method applied and tested by IPSARD is highly applicable and feasible with the rather low image purchase cost: images can be bought every 5 years at the cost of around 10000 USD/province), survey cost is only high in the first year (35.000 USD/province). Every year, yield survey should be conducted and acreage survey can be done every 2 years with the much lighter sampling density. And especially this method can provide highly precise result (90%).

Recommendations

Based on the above survey result and analysis, the following recommendations could be provided:

- It is recommended to further apply this highly feasible and scientific method,. Firstly, this method in Dak Lak should be conducted in 3 continuous years to test the sustainability, accuracy and further adaptation can be done if necessary.
- After successful test of this method, the method should be applied to the nation wide with the following suggestions:
  - Thanks to not too high fluctuation in acreage, the acreage survey can be conducted every 2 years and rotatedly done in provinces nation wide
  - Due to fluctuation of yield being higher than acreage variation, yield survey should be done every year, with much lower costs..
  - Every 5 years, highly densed sampling survey should be done again to adjust necessary parameters..
- This method can also be used to estimate supply of other perenial crops like rubber, pepper and cashew nut.
- Database on acreage, yield and production of coffee should be set up by coffee varieties and provinces. And this database can be made available through connecting with the website of IPSARD/MARD.